2021-03

Compilation of Abstracts, March 2021

Monterey, California; Naval Postgraduate School

NPS-04-21-002

COMPILATION OF ABSTRACTS

Unrestricted Dissertations, Theses, and Final Projects

NPS Class of March 2021

Office of the Vice President and Dean of Research
NAVAL POSTGRADUATE SCHOOL
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PREFACE

This publication, Compilation of Abstracts, contains abstracts of unrestricted dissertations, theses, and capstone project reports submitted for the doctor of philosophy, master of arts, master of business administration, and master of science degrees for the Naval Postgraduate School's March 2021 graduating class. A digital copy of this publication can be found at https://calhoun.nps.edu/handle/10945/67481 while the corresponding metadata can be found at https://calhoun.nps.edu/handle/10945/67198.

This compilation is published to acquaint those interested in the fields represented with the nature and substance of Naval Postgraduate School student research, which covers a wide range of defense-related topics. An online copy of this and previous editions can be found at https://calhoun.nps.edu/handle/10945/27474. Calhoun, the institutional archive of NPS, provides a convenient way to search the content of unrestricted theses. Search for specific full-text theses and dissertations by author, advisor, branch of service, date issued, degree, department, or type at https://calhoun.nps.edu/handle/10945/17.

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For other inquiries about student and faculty research at NPS, please contact the Dean of Research, Dr. Jeffrey Paduan:

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Monterey, CA 93943-5138
Phone: (831) 656-3008
Fax: (831) 656-2038
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For details on degree programs at NPS, please contact the Director of Admissions at (831) 656-3093 or grad-ed@nps.edu. The NPS Admissions Office website is at https://www.nps.edu/web/admissions and the Academic Catalog is available online at https://www.nps.edu/web/registrar/academic-catalog. Visit the NPS homepage at https://nps.edu.

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DOCTOR OF PHILOSOPHY

MASTER OF ARTS IN SECURITY STUDIES

Master of Arts in Security Studies (continued)

MASTER OF BUSINESS ADMINISTRATION

MASTER OF SCIENCE

Master of Science in Computer Science

Master of Science in Cyber Systems and Operations

Master of Science in Electrical Engineering

Master of Science in Management

Master of Science in Management (continued)

Master of Science in Mechanical Engineering

Master of Science in Meteorology & Physical Oceanography

Master of Science in Network Operations and Technology

Master of Science in Operations Research

INTRODUCTION

The Naval Postgraduate School is pleased to present the dissertation, thesis, and capstone project report abstracts for unrestricted research completed in March 2021 by the graduating class.

MISSION

The Naval Postgraduate School (NPS) was established to serve the advanced educational needs of the Navy. The broad responsibility of NPS is reflected in its stated mission:

The Naval Postgraduate School provides defense-focused graduate education, including classified studies and interdisciplinary research, to advance the operational effectiveness, technological leadership, and warfighting advantage of the Naval service.

To fulfill its mission, the Naval Postgraduate School advances innovation in the Navy and prepares officers for employing new technologies. The research program at NPS supports the mission of graduate education. Research at NPS

- advances knowledge in a wide range of disciplines relevant to the Navy/DOD;
- maintains upper-division course content and cutting-edge programs;
- provides the opportunity for students to demonstrate independent graduate-level scholarship in their areas of study;
- challenges students with creative problem-solving experiences on DOD-relevant issues;
- solves warfare problems; and
- attracts and retains quality faculty with state-of-the-art expertise.

To meet its educational requirements, the Navy has developed a unique academic institution at NPS and via distance learning (DL) through specially tailored academic programs and a distinctive educational experience tying academic disciplines to naval and joint warfighting applications. NPS has aligned its education and research programs to achieve three major goals:

1. nationally recognized academic programs that support the operations of the Navy and Marine Corps, our sister services, and our allies;
2. research programs that focus on the integration of education and research in support of current and emerging national security technologies and operations; and
3. executive and continuing education programs that support sustained intellectual innovation and growth throughout an officer's career.

ACADEMIC PROGRAMS

School of International Graduate Studies (SIGS)

The unique programs and faculty expertise within SIGS seek to identify and address current and emerging security challenges and strengthen multilateral and bilateral defense cooperation between the United States and other nations. Areas of expertise range from nuclear nonproliferation to counterterrorism; from the history of war to emerging biological and cyber threats; and from the security aspects of political economy to international law.

- Civil-Military Relations
- Combating Terrorism Strategy and Policy
- Defense Decision Making and Planning
- Homeland Security and Defense
- Security Studies
- Stabilization and Reconstruction
- National Security and Intelligence
  Regional Studies:
  - » Middle East, South Asia, Africa
  - » Far East, Southeast Asia, the Pacific
  - » Europe and Eurasia
  - » Western Hemisphere

Graduate School of Defense Management (GSDM)

GSDM reflects the management side of national defense in support of operational requirements, with programs open to the U.S. uniformed services, DOD employees and contractors, federal employees, and international military and government employees. An integrated civilian and military faculty focuses on defense organizations, system applications, and instruction supported by extensive defense-oriented research.

- Acquisition and Contract Management
- Advanced Acquisition Program
- Contract Management (DL)
- Defense Business Management
- Defense Systems Analysis
- Defense Systems Management
- Executive MBA (DL)
- Financial Management
- Information Systems Management
- Material Logistics Support
- Manpower Systems Analysis
- Program Management (DL)
- Supply-Chain Management
- Systems Acquisition Management
- Transportation Management

Graduate School of Engineering and Applied Sciences (GSEAS)

GSEAS provides advanced education in engineering and applied sciences while developing technological advances with strict application to DOD needs, thus setting it apart from civilian graduate schools of engineering. It is focused on preparing the next generation of U.S. and international leaders, military and civilian alike, for the uncertainties and challenges of a rapidly changing technological world.

- Applied Mathematics
- Combat Systems Sciences and Technology
- Electronic Systems Engineering (residential and DL)
- Mechanical Engineering for Nuclear-trained Officers (DL)
- Meteorology and Oceanography
- Meteorology
- Naval/Mechanical Engineering
- Oceanography
- Operational Oceanography
- Reactors–Mechanical/Electrical Engineering (DL)
- Space Systems Engineering
- Space Systems Operations (residential and DL)
- Systems Engineering (residential and DL)
- Systems Engineering Management (DL)
- Undersea Warfare
- Underwater Acoustic Systems (DL)

Graduate School of Operational and Information Sciences (GSOIS)

GSOIS delivers graduate-level education and conducts cutting-edge research in four non-traditional knowledge domains responsive to U.S. military needs: information science and technology, military computer science, military operations analysis and research, and special operations and related defense analysis.

- Applied Cyber Operations
- Computer Science (residential and DL)
- Computing Technology (DL)
- Cyber Systems and Operations
- Cost Estimating and Analysis (DL)
- Electronic Warfare Systems (international)
- Human Systems Integration
- Identity Management and Cyber Security (residential and DL)
- Information Sciences
- Information Systems and Operations
- Information Systems and Technology
- Information Warfare
- Joint C4I Systems
- Joint Information Operations
- Joint Operational Logistics
- Modeling, Virtual Environments, and Simulation
- Operations Analysis
- Remote Sensing
- Software Engineering (residential and DL)
- Special Operations
- Systems Analysis (DL)

Office of the Provost

The Office of the Provost provides oversight to a specialized degree program that leads to a master of science in systems engineering analysis. Students benefit from cross-disciplinary course offerings and research opportunities found in GSEAS systems engineering and GSOIS systems and operational analysis curricula.

- Systems Engineering Analysis

STUDENT POPULATION

The student body at NPS consists of U.S. officers from all branches of the uniformed services, civilian employees of the federal government, and international military officers and government civilians. The student population distribution for March 2021 is shown in Figure 1 to the right.

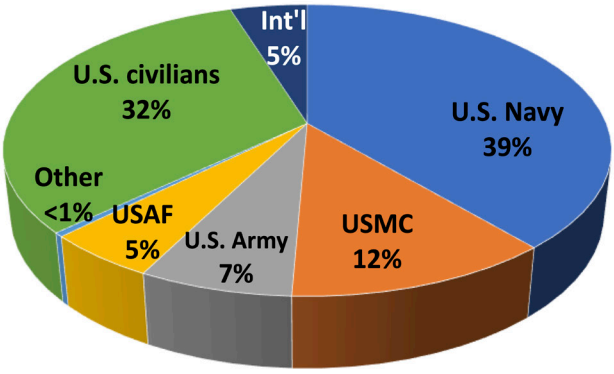


Figure 1. Total enrollment by student type for the winter quarter of 2021. Source: NPS Academic Affairs Quarterly Enrollment Report, AY2021/Quarter 2.

STUDENT RESEARCH

Independent scholarly work in the form of a dissertation (PhD), thesis (master's/engineer), or capstone project is required for most academic programs. Student research projects address issues ranging from the current needs of the fleet and joint forces to the science and technology required to sustain long-term superiority of the Navy and DOD. Guided by faculty advisors, NPS students represent a vital resource within the DOD for addressing warfighting problems and maintaining cutting-edge expertise, particularly in a time when technology and information operations are changing rapidly. Naval Postgraduate School alumni think innovatively and possess the knowledge and skills to apply nascent technologies in the commercial and military sectors. Their firsthand grasp of operations, when combined with challenging projects that require them to apply their focused graduate coursework, is one of the most effective elements in solving fleet, joint-force, and regional problems. NPS graduate education encourages a lifelong capacity for applying basic principles and creative solutions to complex problems. NPS is also unique in its ability to conduct classified research. Classified theses are available on the NPS SIPRNet.

Source: Naval Postgraduate School Public Affairs Office

DEGREES OFFERED

Curricula meet defense requirements within the traditional degree framework through residential or distance-learning programs. The curricula listed below lead to master's, engineer, or doctor of philosophy degrees. NPS also offers certificate and executive education programs, which do not require theses.

Doctor of Philosophy
- Applied Mathematics
- Applied Physics
- Astronautical Engineering
- Computer Science
- Electrical Engineering
- Engineering Acoustics
- Information Sciences
- Mechanical Engineering
- Meteorology
- Modeling, Virtual Environments, and Simulation
- Operations Research
- Physical Oceanography
- Security Studies
- Software Engineering
- Systems Engineering

Engineer
- Astronautical
- Electrical
- Mechanical

Master of Arts
- Identity Management and Cyber Security
- Security Studies

Master of Business Administration
- Master of Business Administration
- Executive Master of Business Administration

Master of Computing Technology

Master of Cost Estimating and Analysis

Master of Engineering
- Computer Engineering
- Electrical Engineering

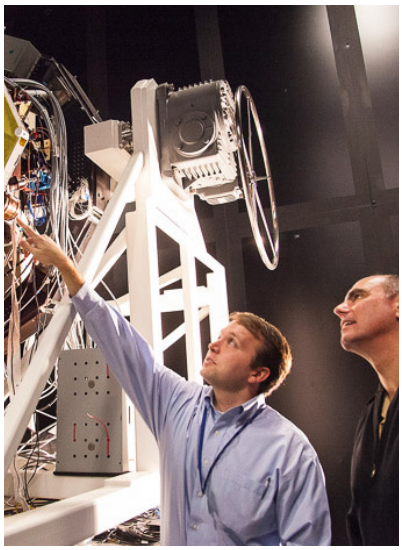
Master of Engineering Acoustics

Master of Human Systems Integration

Master of Science
- Applied Cyber Operations
- Applied Mathematics
- Applied Physics
- Applied Science
- Astronautical Engineering
- Combat Systems Technology
- Computer Science
- Contract Management
- Cyber Systems and Operations
- Defense Analysis
- Electrical Engineering
- Electronic Warfare Systems Engineering
- Engineering Acoustics
- Engineering Science
- Engineering Systems
- Human Systems Integration
- Information Strategy and Political Warfare
- Information Technology Management
- Information Warfare Systems Engineering
- Management
- Mechanical Engineering
- Meteorology
- Meteorology and Physical Oceanography
- Modeling, Virtual Environments, and Simulation
- Network Operations and Technology
- Operations Research
- Physical Oceanography
- Physics
- Product Development
- Program Management
- Remote Sensing Intelligence
- Software Engineering
- Space Systems Operations
- Systems Engineering
- Systems Engineering Analysis
- Systems Engineering Management
- Systems Technology

Master of Systems Analysis

Source: NPS Public Affairs Office

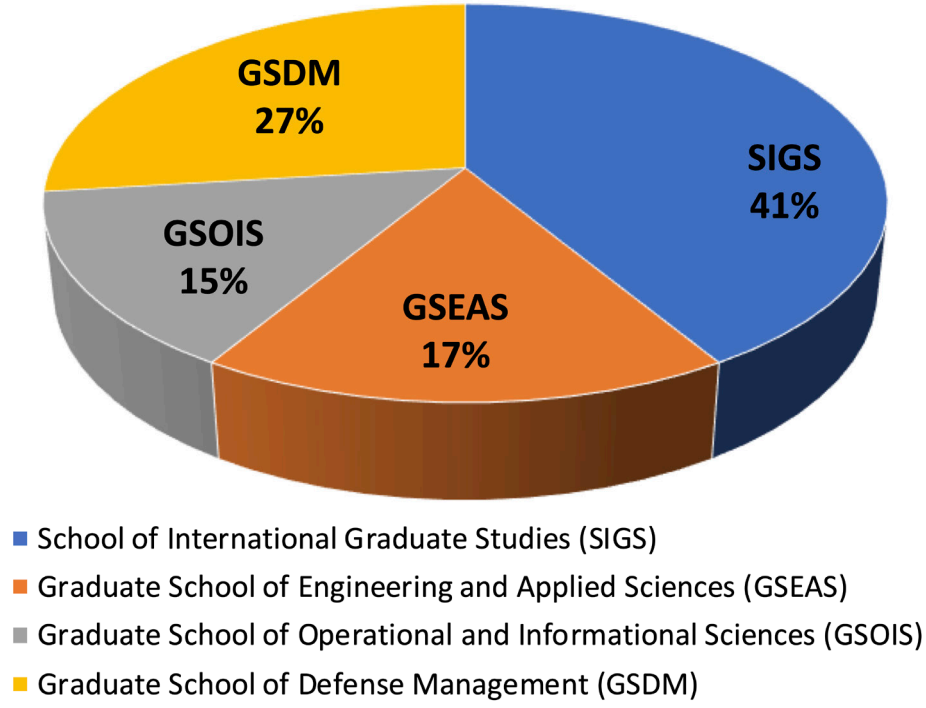


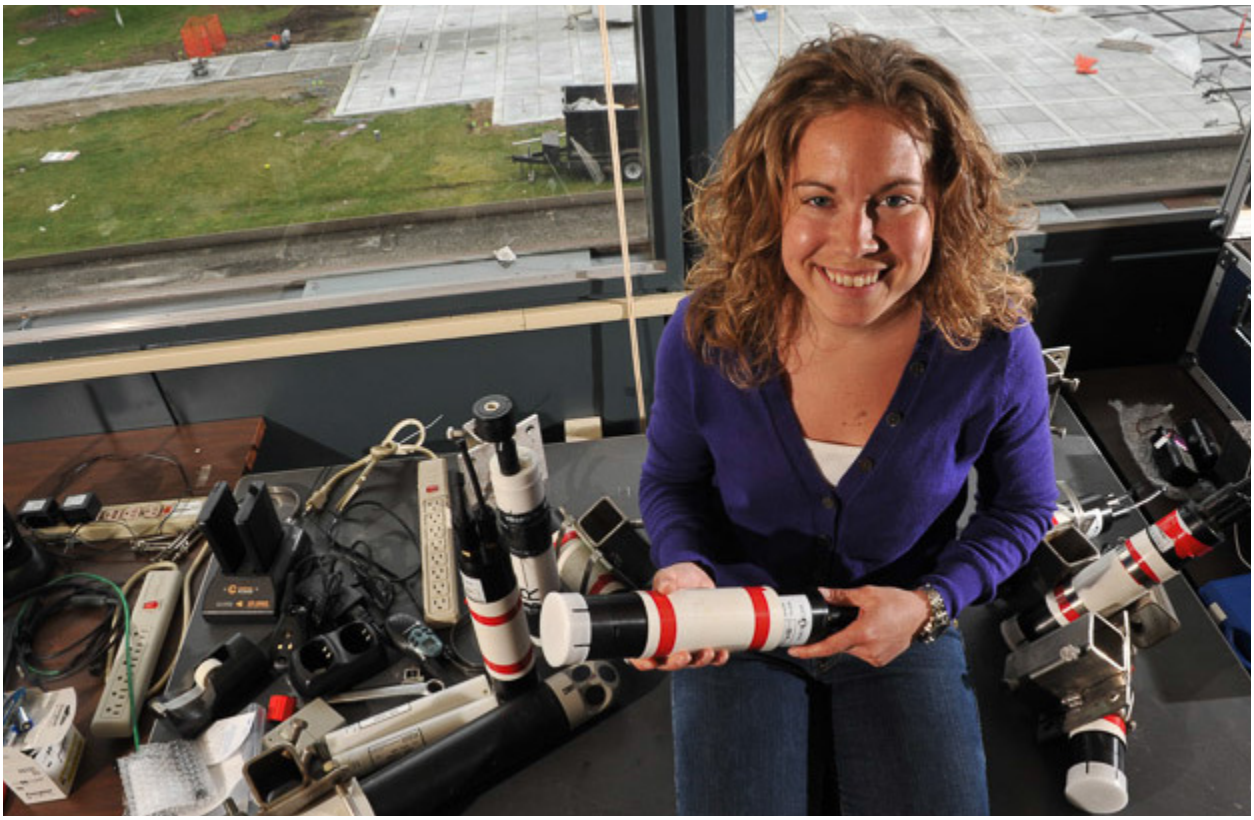
Source: NPS Public Affairs Office

MARCH 2021 THESES AND DEGREES CONFERRED

The March 2021 graduating class produced 104 unrestricted dissertations, theses, and capstone project reports as part of the graduation requirement. Figure 2 indicates the distribution of this published research across each of the four NPS academic schools.

Figure 2. Distribution of unrestricted dissertations, theses, and capstone project reports by NPS academic schools, March 2021





Source: NPS Public Affairs Office

ACADEMIC AWARDS ANNOUNCED MARCH 2021

Many departments honor graduating students for the quality and contributions made by their dissertations, theses, or capstone reports. The following listing recognizes students selected by NPS faculty and military associations for superior academic achievement and outstanding theses.

Campus-Wide

- Monterey Peninsula Council of the Navy League LCDR Tom Winant Highest Academic Achievement Award: Major Kevin Druffel-Rodriquez, U.S. Marine Corps
- Association of the United States Army, General Joseph W. Stilwell Chapter, Award for Outstanding Army Student: Major Daniel Zuniga, U.S. Army
- Naval Postgraduate School Outstanding Academic Achievement Award for International Students: Captain Anders Suvari, Estonian Special Operations Force
- Air Force Association Award for Outstanding U.S. Air Force Student: Major Celestine K. Lukshis, U.S. Air Force
- Naval Postgraduate School Superior Service Award: Major Celestine K. Lukshis, U.S. Air Force
- Marine Corps Association Superior Service Award for Outstanding U.S. Marine Student: Staff Sergeant Warren Diffey, U.S. Marine Corps
- The Surface Navy Association's Award for Excellence in Surface Warfare Research: Lieutenant Daniel Pulliam, U.S. Navy
- Military Operations Research Society Stephen A. Tisdale Graduate Research Award: Lieutenant Daniel Pulliam, U.S. Navy
- Chief of Naval Operations Undersea Warfare Award: Lieutenant David A. Kramer, U.S. Navy
- The Curtis H. "Butch" Straub Achievement Award: Chief Martin Birkenfeld, Jr., Amarillo (Texas) Police Department

Graduate School of Defense Management (GSDM)

- Chief of Naval Personnel Award for Academic Excellence in Manpower Systems Analysis: Lieutenant Commander Kevan Mellendick, U.S. Navy, and Captain Brandon Eliason, U.S. Marine Corps
- The Louis D. Liskin Award for Excellence in Management: Captain Barry Loseke, U.S. Marine Corps

Graduate School of Engineering and Applied Sciences (GSEAS)

- The John McReynolds Wozencraft Electrical and Computer Engineering Academic Honor Award: ME 5 Yu Kheng Denny Cheng, Republic of Singapore Navy
- Naval Sea Systems Command Award in Naval/Mechanical Engineering: Lieutenant Jeffrey C. Mitchell, U.S. Navy
- Meyer Award for Outstanding Student in Systems Engineering (Distance Learning): Alexandra L. Kilmon and Commander Brian Christopher Fredrick, U.S. Navy

Graduate School of Operations and Information Sciences (GSOIS)

- Chief of Naval Operations Award for Excellence in Operations Research: Lieutenant Commander Christopher Norman, U.S. Navy
- Rear Admiral Grace Murray Hopper Computer Science Award: Lieutenant Commander Eric Regnier, U.S. Navy

School of International Graduate Studies (SIGS)

- The Louis D. Liskin Award for Excellence in Regional Security Studies: Major Lyndsey L. Horn, U.S. Air Force
- The Outstanding United States Air Force Graduate Award, Department of National Security Affairs: Major Lyndsey L. Horn, U.S. Air Force
- The International Student Award for Excellence in Regional or Security Studies: Commander Abdul K. Dumbuya, NAVY, Sierra Leone

Outstanding Thesis Recognition

- Major John M. Bailey, U.S. Marine Corps: *Marine Corps Military Occupational Specialty (MOS) Assignments: Career Impacts of Match Quality*
- Captain Ansley White, U.S. Marine Corps: *Effects of Preferred Duty Station Assignment on the Performance and Retention of USMC Personnel*
- Lieutenant Harvey D. Manley, III, U.S. Navy: *Oases of Influence: Geopolitical Implications of China's Economic Engagement with the Arab World*
- Captain Seungwan Cho, Republic of Korea Army: *AI-Based UXO Detection Using SUAS Equipped with a Single- or Multi-Spectrum EO Sensor*
- Mr. Jonathan M. Graham, Civilian, Department of Homeland Security: *Strategic Communications and the Department of Homeland Security: Immigration Policies, Mixed Messaging, and Information Fratricide*
- Lieutenant Tyler J. Barker, U.S. Navy: *Emerging Space Programs in Sub-Saharan Africa*
- Commander David Barnhill, U.S. Navy: *Analyzing U.S. Navy F/A-18 Fuel Consumption for Purposes of Energy Conservation*
- Captain Nicholas Norville, U.S. Marine Corps: *Improving USMC Retention Quality through Reenlistment Pre-Approval*
- Captain Jihye Kim, Republic of Korea Army: *User Identification in Dynamic Web Traffic Via Deep Temporal Features*
- Lieutenant Daniel B. Pulliam, U.S. Navy: *Developing a Framework for Analyzing the Resilience of Forward Expeditionary Port Refueling Infrastructure*
- Mr. Peter J. Pommer, Civilian, CyberCorps Scholarship for Service: *Design and Implementation of a Distributed Ledger to Support Data Survivability in an Unmanned Multi-Vehicle System*
- Lieutenant Kevin D. Lutz, U.S. Navy: *Challenges of Using Inconsistent Head Poses to Classify Deepfakes*
- Lieutenant Curtis D. Bolen, U.S. Navy; Ms. Victoria Chu, Civilian, Department of the Navy; Mr. Andy Q. Dang, Civilian, Department of the Navy; Mr. Paul T. Kim, Civilian, Department of the Navy; Mr. Christian Proctor, Civilian, Department of the Navy; and Ms. Bridget R. Shideler, Civilian, Department of the Navy: *Integrating Power-Flow, Resilience, and Cost Models for Naval Installation Microgrids*
- Lieutenant Jeffrey C. Mitchell, U.S. Navy: *Substrate and Feedstock Factors Affecting Cold Spray Coating Adhesion and Related Impacts of Corrosion*
- Lieutenant Commander Jordan T. Penland, U.S. Navy: *Branding the Enemy: The "Kharijite" Label and the Legitimation of State Power*
- Captain Amanda Henegar, U.S. Marine Corps: *Parenthood and its Effects on the Health and Performance of Dual-Military Marines*
- Mr. Brian T. Hollan, Civilian, *Metropolitan Police Department (Washington, D.C.): Policing for the 22nd Century: A Complexity Theory-Based Approach*

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DOCTOR OF PHILOSOPHY

TECHNOLOGY TRUST: THE IMPACT OF ANTHROPOMORPHIC SYSTEM INFORMATION ON THE ACCEPTANCE OF AUTONOMOUS SYSTEMS USED IN HIGH-RISK APPLICATIONS

Michael G. Anderson, Civilian, Department of the Navy

Doctor of Philosophy in Information Sciences

Dissertation Supervisor:
Johnathan C. Mun, Department of Information Sciences

Dissertation Committee Members:
Kathryn J. Aten, Graduate School of Defense Management
Jacob Norris, Office of Naval Research
Shelley P. Gallup, Department of Information Sciences
Thomas J. Housel, Department of Information Sciences

Autonomous systems provide the military with advanced capabilities permitting the execution of increasingly dangerous and difficult missions. A human in the loop is still required to decide how and when to deploy these technologies. The research problem this dissertation addresses is a user's rejection of new technology in high-risk applications due to a lack of trust in the use of the technology. This is a problem because users' lack of trust in new technology, designed to support users in high-risk situations, will prevent the use of the technology. The purpose of this dissertation is to investigate the effect of information presented about a new technology as well as the effect of the level of automation offered by the new technology on the perceived trust (i.e., as measured by the perceived usefulness, ease of use, and intent to use). An experiment was conducted that manipulated the level of automation and the presentation of information in three systems. The results indicated that, in high-risk scenarios, it is not possible to develop trust in technology without the system presentation of operational information. The study results also indicated that the level of automation was not a factor in developing technology trust in high-risk scenarios.

Keywords: technology trust, autonomous systems, technology risk, anthropomorphic hierarchy, technology system attributes, technology acceptance

MEDIA EFFECTS ON CYBER INTRUSIONS

Mitchell J. McCarthy, Civilian, Department of the Navy

Doctor of Philosophy in Information Sciences

Dissertation Supervisor:
Timothy C. Warren, Department of Defense Analysis

Dissertation Committee Members:
Dan C. Boger, Department of Information Sciences
Wayne Porter, Department of Defense Analysis
Douglas J. MacKinnon, Department of Information Sciences
Raymond R. Buettner Jr., Department of Information Sciences

In this current hyperconnected era, many could argue that multifaced daily news events, arranged into univocal storylines, generate effects well beyond the media environment. Empirically speaking, most explorations of media and cyberspace focus discretely on one or the other, parochially missing their potential interaction. More specifically, could negative media events, laced with dueling narratives, aimed at the United States and its interests by other countries on a given day, impact the level of cyber intrusions on U.S. networks the next day? The purpose of this study is to relate today's recorded cyber intrusions on a U.S. network to yesterday's media events using statistical regression models as the method of testing for the relationship's existence. The analysis begins with a broad investigation of all regimes, and then proceeds through specific regime types, before narrowing down to case studies of specific countries. The evidence provided from these models bears out that negative media narratives projected by other countries toward the U.S. generate measurable impacts on the level of ensuing intrusions on U.S. networks. Furthermore, these effects vary in important ways across countries and regime types contingent upon their unique culture, political context, and evolutionary setting.

Keywords: media effects theory, narrative theory, two-level theory of international affairs, two-step flow of media effects, conflict and rivalry, digital panopticon, sharp power, democracies, anocracies, autocracies, negative media tone, negative media polarization, negative material narratives, negative verbal narratives, cyber intrusions

MASTER OF ARTS IN SECURITY STUDIES

INDIA'S PURSUIT OF SEA-BASED STRATEGIC DETERRENCE: SECURITY CONCERNS ON THE PATH TO A CREDIBLE DETERRENCE

Tony H. An, Lieutenant, United States Navy
Master of Arts in Security Studies (Middle East, South Asia, Sub-Saharan Africa)
Co-Advisor: Feroz H. Khan, Department of National Security Affairs
Co-Advisor: Anshu N. Chatterjee, Department of National Security Affairs

India continues its resolve in developing a sea-based strategic deterrence in the form of nuclear ballistic missile submarines (SSBN) carrying ballistic missiles. India's ability to maintain security and stability within the Indian Ocean Region (IOR) is increasing as the United States seeks to share its security responsibility. The IOR continues to gain importance within the international order as the stability of the world's economy depends on the security of these oceans. Rising powers such as China depend heavily upon resources that flow through the IOR and thus have great interest in influencing the security landscape of the region. India, situated in the center of the IOR, is also seeking to achieve great power status through influencing this region of the world. The security situation in this region is also unique in that the three major nations within this region are nuclear powers and have various levels of conflict under the nuclear umbrella. Pakistan and India continue to war over Kashmir and other such partition issues. China and India also have legacy border disputes that occasionally see clashes. This thesis finds that India's security concerns will not be alleviated with sea-based nuclear weapons. The development of SSBNs will come at the expense of much needed conventional naval modernization, which is more suited for addressing India's security concerns.

Keywords: India, nuclear deterrence, sea based strategic deterrence, ballistic missile nuclear submarine, SSBN, China, Pakistan

BEYOND REFORM: BETTER POLICING THROUGH SYSTEMS THINKING

Christopher R. Bagby, Sergeant, Bakersfield (Calif.) Police Department
Master of Arts in Security Studies (Homeland Security and Defense)
Co-Advisor: Patrick E. Miller (contractor), Center for Homeland Defense and Security
Co-Advisor: Shannon A. Brown, Center for Homeland Defense and Security

Police reform is a long-standing objective in America. In one form or another, the same fundamental problem persists: police have never consistently navigated the tension between effectively policing society and being a part of it. In part, systems theory helps explain why traditional best-practice reforms have not been consistently effective. The solution to these problems may lie not in reform but in reframing the approach to police organizations through systems thinking. This thesis seeks to answer a key question predicated on the assumption that reform is not enough: How can systems thinking improve policing? Using gap analysis, this thesis identifies ways to improve American policing and its processes through application of systems theory, specifically systems thinking. This research considers some of the problems that face policing from a systems-thinking perspective and finds that managing systems structures, building agent capacity, understanding context and goal-setting, and pursuing feedback could improve policing in ways that traditional reform strategies have not. Finally, it recommends that law enforcement agencies adopt systems-thinking strategies to improve performance.

Keywords: police, police reform, systems, systems thinking, policing, policing management, reflective practice, knowledge management, system context, organizational management

I'VE GOT MY AI ON YOU: ARTIFICIAL INTELLIGENCE IN THE LAW ENFORCEMENT DOMAIN

Eric M. Baker, Intelligence Systems Analyst, Texas Department of Public Safety
Master of Arts in Security Studies (Homeland Security and Defense)
Co-Advisor: Erik J. Dahl, Department of National Security Affairs
Co-Advisor: Anthony Canan, Department of Information Sciences

Artificial Intelligence (AI) systems provide a unique problem for users in the law enforcement domain. On one hand, AI systems provide an opportunity for optimizations and faster workflows, especially in the environment of growing data. On the other hand, if left unchecked, AI systems have the potential to negatively affect the community served by law enforcement. This research focuses on three types of AI systems currently used by law enforcement: facial recognition, predictive risk assessments, and predictive policing. By looking at these three types of AI systems, this research attempts to evaluate the effectiveness of the technology while maintaining the privacy, fairness, transparency, and accountability expected by the public. These three case studies show how AI systems can have a negative impact on individuals identified via AI systems and the need for further research into effective measures to regulate the technology. Additionally, the European Union is currently working on potential frameworks for responsible implementation of AI systems, which provide a template for future efforts in the United States.

Keywords: artificial intelligence, machine learning, AI

EMERGING SPACE PROGRAMS IN SUB-SAHARAN AFRICA

This paper has been recognized as outstanding by its department.

Tyler J. Barker, Lieutenant, United States Navy
Master of Arts in Security Studies (Middle East, South Asia, Sub-Saharan Africa)
Advisor: Rachel L. Sigman, Department of National Security Affairs
Second Reader: James C. Moltz, Department of National Security Affairs

Sub-Saharan African countries with established space programs have pursued a variety of different space policies, some focusing on national security, some focusing on socioeconomic development, or some on a mix of the two. Which factors—foreign partners, domestic politics, bureaucratic institutions, or economic capacity—are the strongest drivers of these policy decisions in African space programs? This thesis uses a qualitative case study analysis of the two most advanced space programs in sub-Saharan Africa, South Africa and Nigeria, to address the research question. Each case study provides a brief history of the country's space program before analyzing the roles each factor plays in space policy decisions. In both South Africa and Nigeria, only domestic political priorities had a strong impact on the space programs' trajectories, while the remaining factors exhibited either weak influence or no influence. The strength of the political priorities hypothesis suggests a high degree of political agency and national pride in each country's space program, which contrasts with typical "Afro-pessimist" approaches to African studies. If U.S. leaders desire to improve geopolitical relationships with strategic partners in Africa, thereby counterbalancing great power competition on the continent, the U.S. should assist African countries in implementing their political priorities by increasing space cooperation with African countries across the commercial, civil, and military sectors.

Keywords: space policy, South Africa, Nigeria, developing countries, emerging space actors, sub-Saharan Africa, space programs

CONNECTING LAW ENFORCEMENT RECORDS MANAGEMENT SYSTEMS

Martin L. Birkenfeld Jr., Chief of Police, City of Amarillo, Texas
Master of Arts in Security Studies (Homeland Security and Defense)
Co-Advisor: Patrick E. Miller (contractor), Center for Homeland Defense and Security
Co-Advisor: Erik J. Dahl, Department of National Security Affairs

Every law enforcement agency uses records management systems (RMS) that contain a wealth of information essential for investigations or intelligence. This information includes crime reports, arrest reports, name records, and property records. The ability to share this information between law enforcement agencies, especially those with bordering jurisdictions, would appear beneficial to the homeland security enterprise; however, this thesis reveals that sharing RMS data is not occurring as often as expected. Direct RMS connections are uncommon, and law enforcement agencies possess valuable information hemmed off in seclusion. This thesis examines a research-based RMS model and other systems that attempt to solve the data-sharing problem. One case study reveals the costly failure of a records system commissioned by the FBI. A survey and interviews of Texas police agencies reveal gaps in information sharing, including many not furnishing data to exchange networks. Although fusion centers and regional information-sharing systems (RISS) provide valuable intelligence and investigative products, many police agencies do not use these resources. How can law enforcement improve information sharing? The answer requires agency leaders to become educated on the many resources available and break down bureaucratic or political barriers that prevent the automated sharing of law enforcement RMS data.

Keywords: police records management, RMS, records management systems, law enforcement records management systems, law enforcement information sharing, national data exchange, N-DEx

GETTING IT WRONG: A CRITIQUE OF THE CIA'S EARLY COVERT OPERATIONS

Nicholas I. Bryant, Lieutenant, United States Navy
Master of Arts in Security Studies (Western Hemisphere)
Advisor: Christopher N. Darnton, Department of National Security Affairs
Second Reader: Erik J. Dahl, Department of National Security Affairs

The CIA's initial regime change operations between 1953 to 1961 were marred by intelligence leaks and lacked critical mission assessments. In addition, perceptions held by top-level decision makers were so distorted that unsupported claims of communist infiltration were made in order to support the decision to proceed with an operation. Three operations were conducted in the span of eight years with nearly indistinguishable similarity, and the third operation resulted in failure. It was only after that failure that investigations revealed the extent of the problem. After examining these three cases, this thesis concludes that the accrual of misperceptions with regard to intelligence and unexamined mission tactics led to the failure at the Bay of Pigs.

Keywords: CIA, organizational learning, regime change, international affairs

EVERY COMMUNITY AN ISLAND: PREPARING FOR CATASTROPHIC DISASTERS

Sean Card, Preparedness and Analysis Branch Chief,
FEMA Region II, Department of Homeland Security
Master of Arts in Security Studies (Homeland Security and Defense)
Co-Advisor: Glen L. Woodbury, Center for Homeland Defense and Security
Co-Advisor: Nadav Morag (contractor), Center for Homeland Defense and Security

This thesis is a single-case study of Puerto Rico's experience with Hurricane Maria and its catastrophic impacts. As the nation faces more complex and frequent catastrophic disasters, practitioners must consider how to build resilience in a meaningful way by beginning with the community. America's approach to disaster preparedness and response outlined in the National Preparedness Goal (NPG) and the National Response Framework (NRF) has respectively produced "whole community" concepts and a tiered response approach to disasters. However, the NPG has yet to realize the concept of "whole community" fully by effectively integrating community-based actors and other non-governmental entities into disaster preparedness, response, and recovery cycles. The NRF also does not outline contingencies for the collapse of the framework in catastrophic disasters when mutual aid, state, and federal resources become unavailable or insufficient for lengthy periods of time, leaving communities isolated. To examine these issues, Puerto Rico's disaster impacts are examined via the Federal Emergency Management Agency's community lifelines as a categorical method of organization. By synthesizing a large body of literature, this study provides disaster preparedness and response conclusions for all lifelines and identifies overarching themes centered upon a need for holistic disaster preparedness, integration of non-governmental actors, decentralization, and redundant critical infrastructure systems.

Keywords: National Preparedness Goal, NPG, National Response Framework, NRF, disaster resilience, community preparedness, catastrophic disaster preparedness, preparedness, resilience

THE BARRIERS LATIN AMERICAN COUNTRIES FACE WITH FEMALE INTEGRATION INTO COMBAT ROLES: A COMPARATIVE STUDY

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Globally, only 23 countries recognize women as indispensable support in combat positions. American and Norwegian women are effectively utilized in Female Engagement Teams, and Israeli women are known to enhance combat effectiveness in infantry units. Nevertheless, gender gaps in equality still remain, particularly in Latin American militaries. In this thesis, Norway, Israel, and the United States illustrate the differing approaches and successes of female integration into combat positions. It seeks to identify what measures could be applied to Latin American militaries desiring added diversity. Evidence indicates that distinct cultural norms have either effectively assisted or impeded the advancement of women's employment into combat specialties. In Norway and Israel, the inclusion of women in the armed forces was dependent on affirmative legislative action toward gender equality. The United States demonstrated a lack of leadership support that hindered women's integration. In all cases, cultural norms featuring hegemonic masculinities impeded female participation in primary combat positions. Women in Latin America—a region with a similar cultural misogyny—will likely face the same types of obstacles to service in combat roles. By emulating Norway's framework, Latin American states would have the ability to force cultural change that potentially closes gender gaps and empowers the region's governments to improve the conditions of women wishing to serve in combat specialties.

Keywords: Latin American region, women in combat, gender mainstreaming, gender equality, critical mass theory, hegemonic masculinity, cohesion, misogyny, machismo, discriminations, biases, special elite billets, cultural disparities, evolution, leadership, social acceptance

THE ROLE OF RUSSIAN SUBMARINES IN RUSSIAN MARITIME STRATEGY

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This thesis evaluates the recent improvement of Russia's submarine program in light of the overall modernization of Russia's undersea capabilities. It is based on a combination of qualitative assessments from unclassified official publications from Russian maritime defense institutions, historical articles on Soviet submarine development, along with their use during the Soviet era, and contemporary studies of Russian submarines. It concludes that the Russian Navy is well on its way to replacing an aged Soviet submarine force with a smaller but more technologically advanced nuclear submarine fleet. Improved Russian submarines are employed in a variety of roles to blunt American strategic innovation. Russia's Deep-Water Special Operating Submarines (DWSOS) and its Oceanographic Research Vessels (ORV), in particular, are employed to reinforce a policy that aims to advance Russia's influence abroad. Russia's navy will undoubtedly attempt to counteract any improvements realized by the U.S. Navy to the extent it can. In that sense, Russian naval strategy will remain reactive to that of the United States and its European neighbors for the foreseeable future.

Keywords: Russia, Russian, nuclear, diesel, SSBN, SSN, hybrid, warfare, deterrence, submarines, Cold War, strategy, Soviet Union, bastions, navy, naval, Stalin, maritime, strategic, sea, admiral, undersea, cables, underwater, communication, missile, mission, the West

THE CROWD MACHINE: LEVERAGING EMERGENT CROWD BEHAVIOR IN POLICY AND RESPONSE

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All across the country, officials and planners of the first-responder community plan for events of various types, yet their plans do not adequately account for crowd behavior when the event is interrupted by an act of violence that turns into a mass-casualty incident, or a "focus event." This research contests early crowd psychology studies and presents the contemporary social identity theory, elaborated social identity model, and emergence model as better lenses for crowd behavior in responding to a focus event. Case studies of the 2013 Boston Marathon bombing and the 2017 Las Vegas mass shooting are used to analyze crowds that experienced focus events through the perspective of complex adaptive systems. A new framework that incorporates the elements of stress, panic, chaos, and priming is then presented to assist officials and planners with planning for crowds experiencing a focus event, with the aim of leveraging crowd emergence. The new framework presented in this research leads to a set of actionable recommendations for policymakers and planners. Ultimately, this thesis challenges officials and planners of the first-responder community to evaluate crowds as complex adaptive systems and explore the ability to leverage crowds for a more effective response.

Keywords: crowds, crowd behavior, focus event, Boston Marathon bombing, Las Vegas shooting, CAS, complex adaptive systems, emergence, stress, panic, chaos, priming

POLICING THE AEROTROPOLIS: A MODEL FOR SECURING THE NATION'S LARGE AIRPORTS

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As aviation continues to be the fastest and most efficient form of global transportation, airports across the country continue to see exponential growth in size and population. This expansion means airports will remain a high-value target to crime and terrorism. The need to protect the airport environment against these threats is essential. The responsibility of policing the nation's major airports is unique and full of challenges. Airport police must balance the requirements of providing security to a critical infrastructure and highly transient population, with the needs of protecting the surrounding businesses and commercial developments around the airport. This research answers the question of whether traditional policing models are effective in protecting and serving this unique environment or if a new model should be adapted to suit the needs of policing the aerotropolis better. Research findings, combined with a comparative analysis of policing methods at major U.S. airports, show that a dedicated, highly proactive, and customer-oriented police force is vital in ensuring the nation's large airports and the aviation industry continue to play a vital role in the world economy.

Keywords: airport, aerotropolis, aviation, police, policing, law enforcement, security, critical infrastructure

SECURITY COOPERATION WITH CUBA: THE IMPACT OF NORMALIZATION ON THE COAST GUARD'S RELATIONSHIP WITH THE CUBAN BORDER GUARD

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This research examines the Coast Guard's maritime security relationship with the Cuban Border Guard—before, during, and after normalization—through a qualitative case study comparison of five distinct mission areas: drug interdiction, migrant interdiction, search and rescue, marine environmental protection, and port security. By reviewing the aftereffects of the Trump administration's rollback of U.S.-Cuba policy, specifically the impact on the Coast Guard-Cuban Border Guard security relationship, it is possible to recognize that such a policy reversal does not serve the national security interests of the United States. The operational focus of the Coast Guard's maritime security cooperation with the Cuban Border Guard, combined with measured growth in mission areas of mutual concern, are key factors in the long-term success of this important relationship. With no significant concentration of bilateral security exchanges since 2018, the United States should take steps to reinvigorate law enforcement cooperation with Cuban authorities in areas such as counternarcotics, illegal migration, counterterrorism, and mass rescue operations.

Keywords: counterdrug, counternarcotics, drug interdiction, illegal migration, human smuggling, migrant interdiction, search and rescue, mass rescue operations, security cooperation, information sharing, marine environmental protection, oil spill response, port security, maritime security, maritime law enforcement, national security, Cuba, Coast Guard, Cuban Border Guard

CHALLENGES FACING CIVILIAN CONTROL OF THE MILITARY AND THEIR IMPACT ON DEMOCRATIC CONSOLIDATION: THE CASE OF SIERRA LEONE

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Developing democracies, especially in countries such as Sierra Leone, that have experienced military interventions in politics, face challenges in establishing civilian control over their armed forces. Until the UK-led post-war defense reform of 2002, Sierra Leone's military was politicized and had a history of intervening in politics following the country's independence in 1961. While the government is still consolidating post-reform gains, attendant problems of civilian control are apparent. Using a case study method, this thesis investigates the challenges to civilian control of the military in Sierra Leone. The study tests four hypotheses that relate to military prerogatives, politicization of the military and acceptance of civilian supremacy, engagement in domestic security, and limited civilian defense expertise or interest. The thesis finds that military engagement in domestic security and civilian leadership's limited defense expertise or interest pose potential risks to democratic civilian control of the military. The risks of heightened military prerogatives and politicization are currently low, making them less worrisome. Failing to address these two challenges, however, increases the likelihood for the latter two to become risks as all four factors are found interrelated. The thesis recommends policy action to enhance and strengthen military acceptance of civilian supremacy, civilian defense expertise and interest, institutional control, and resource provision.

Keywords: civilian control, military prerogatives, ministry of defense, civilian supremacy, civil-military relations

THE CRISIS OF LEGITIMACY AFTER POLICE-RELATED CIVILIAN DEATHS: APPLYING THE CYNEFIN FRAMEWORK TO LEGITIMACY-DEVELOPING POLICIES

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Police-related civilian deaths, caused by direct force or occurring during custody, pose one of the central challenges to police legitimacy. This thesis studied five police departments that experienced such a crisis of legitimacy, as evidenced by either deadly retaliatory violence against police or substantial civil unrest in response. Specifically, this thesis examined how each agency implemented expert-recommended legitimacy-developing policies before and in response to the challenge of these deaths. This thesis then applied the Cynefin framework to these implementations, revealing which domains better conform to expert recommendations and sustain legitimacy policies in the wake of a crisis. This research recommends and provides a method for police leaders to leverage the Cynefin framework to assess their legitimacy policy implementations.

Keywords: police, New York, Eric Garner, Daniel Pantaleo, Ferguson, Michael Brown, Darren Wilson, Baltimore, Freddie Gray, Baton Rouge, Alton Sterling, Falcon Heights, St. Anthony, Philando Castile, legitimacy, Tyler, crisis

STRATEGIC COMMUNICATIONS AND THE DEPARTMENT OF HOMELAND SECURITY: IMMIGRATION POLICIES, MIXED MESSAGING, AND INFORMATION FRATRICIDE

This paper has been recognized as outstanding by its department.

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Under President Trump, the Department of Homeland Security (DHS) rolled out the controversial parent-child separation policy, also known as zero tolerance, and the Migrant Protection Protocols (MPP) program in 2018–19. How DHS conducts strategic communications about such controversial policies is directly related to public and stakeholder perception of these policies. A newly developed stakeholder-centric measurement and evaluation model used to evaluate these two policy case studies demonstrates that Trump's DHS used messaging which was, at times, inconsistent and even contradictory. While communications on MPP showed an evolution in DHS's ability to successfully engage in strategic communications related to these enforcement efforts, the parent-child separation policy represents the prototypical example of information fratricide. The research methodology adopts an outsider viewpoint and employs a media content analysis of high-level public communications of DHS officials. Identification and future use of DHS's top communications strengths, as displayed in these sample communications, can lead to more effective strategic communications and improved stakeholder engagement. The thesis concludes with generalized recommendations for future communications policy within DHS based on lessons learned from this thesis research.

Keywords: strategic communications, immigration enforcement, immigration policy, measurement and evaluation of communications, information fratricide, mixed messaging, public communications, parent-child separation, Migrant Protection Protocols, MPP, asylum policy, Department of Homeland Security, DHS, Immigration and Customs Enforcement, policy recommendations

WHY HAVE SOME SOUTHEAST ASIAN RESPONSES TO CHINESE ACTIONS IN THE SOUTH CHINA SEA BEEN MORE SUCCESSFUL THAN OTHERS?

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Over the past decade, Southeast Asian countries have struggled to devise effective responses to China's efforts to assert its claims in the South China Sea. This thesis aims to explain why some of those responses have been more successful than others. Using five case studies from 2012–2020, this thesis examines how the following four factors account for the success or failure of Vietnamese and Malaysian responses: increased external balancing with the U.S., increased internal balancing, increased coercive diplomacy, and stronger diplomatic support from the international community. The thesis finds that successful responses rely on a combination of internal balancing with coercive diplomacy and international support. It finds only weak evidence that countries in Southeast Asia engage in external balancing in response to China's actions in the region. These conclusions suggest that the United States should increase its diplomatic and military cooperation with Southeast Asian partners in ways that enhance their capacity to deploy maritime forces and generate international support in response to Chinese assertiveness. Future research should examine whether increased military cooperation with middle powers such as India and Australia may contribute to more successful outcomes.

Keywords: Southeast Asian responses, regional responses, South China Sea, Chinese coast guard, Chinese maritime militia

NORMALIZING CYBERSECURITY: IMPROVING CYBER INCIDENT RESPONSE WITH THE INCIDENT COMMAND SYSTEM

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In 2018, the Colorado Department of Transportation was hit with a ransomware attack that resulted in the first-ever state emergency declaration for a cyber attack. Cyber attacks against the nation and its infrastructure are expected to increase, yet no extensive research exists on the United States' designated response framework for them. This thesis investigated the application of the Incident Command System (ICS) in significant cyber incidents and how the system may be improved for these events. A mixed method study consisting of case studies, senior leader interviews, and a quantitative survey was used to evaluate ICS specific to the framework's eight core concepts. The research includes findings on variables that impact the effectiveness of response frameworks in cyber events. Recommendations are made to improve cyber response.

Keywords: Incident Command System, ICS, National Incident Management System, NIMS, cyber response, cybersecurity, survey, interview, case study, ransomware, significant cyber incident, core concept

POLICING FOR THE 22ND CENTURY: A COMPLEXITY THEORY–BASED APPROACH

This paper has been recognized as outstanding by its department.

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Although many alternatives to the standard model of policing have been proposed, none of them meaningfully engages with the massive social and technological changes that have occurred since the mid-20th century. This thesis asks if complexity theory can serve as a theoretical foundation for a new model of policing. Literature on complexity, complex adaptive systems, and network theory is examined and finds that observed behavior of street robberies in Washington, DC, can be understood as a complex adaptive system. This thesis concludes that it is vital to recognize that the United States is transitioning into an informational, network-based society increasingly governed by nonlinear, dynamic processes. It also concludes that the present dissatisfaction with the state of policing is due to its institutional misalignment with those social dynamics. Several recommendations are offered on how to educate and structure police agencies to function effectively in complex environments.

Keywords: complexity, complex adaptive system, network, netwar, policing, cynefin

VARIATIONS OF U.S. PUBLIC DIPLOMACY IN CENTRAL AMERICA'S NORTHERN TRIANGLE

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This thesis utilizes a soft power framework to examine U.S. public diplomacy (PD) efforts in Central America's Northern Triangle—El Salvador, Honduras, and Guatemala—between 2009 and 2016. During this period, the region experienced seemingly similar security, development, and migration challenges that affected U.S. foreign policy objectives; however, what would explain any variation in U.S. PD approaches to persuade or attract the host nation's public within these three countries? This thesis analyzes U.S. foreign policy targeting El Salvador, Honduras, and Guatemala, and then looks at complementary U.S. PD efforts from high-level official speeches and strategic communication (via conventional and social media). Overall, this thesis finds that variation in U.S. public diplomacy efforts across Central America's Northern Triangle between 2009 and 2016 was the result of differences in the U.S. government's prioritization of different soft power initiatives to support democracy. In El Salvador, the U.S. focused on strengthening its relationship with the executive branch; in Honduras, the U.S. centered on reestablishing the presidency after the military coup; and in Guatemala, the U.S. prioritized fighting corruption and impunity at the highest levels of government, including the presidency. Lastly, this thesis provides recommendations for the Biden administration as it seeks to attract target audiences in the Northern Triangle in conjunction with its foreign policy.

Keywords: public diplomacy, U.S. foreign policy, soft power, smart power, Central America, Northern Triangle, strategic communication

IN THE LINE OF FIRE: SAFEGUARDING AMERICA'S ELECTION SECURITY

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The U.S. electoral system and democracy are under continued attack by foreign adversaries and political extremists intent on manipulating U.S. elections. Election officials and homeland security stakeholders must search for alternative methods to help strengthen the resiliency of the system. The question then becomes: How can red teaming and systems thinking be applied to reinforce the integrity of the U.S. electoral system? The goal is to analyze the system in its entirety to ensure the system in place can support a free and fair election and withstand an attack from an adversary. This research studies how the rapid implementation of universal mail-in voting created the opportunity for political activists to cast doubt on the validity of the election results. By applying systems thinking to the implementation of mail-in voting, election officials would have identified the additional challenges in advance and employed security protocols and alternative options to mitigate potential threats. To test security protocols in place, stakeholders should employ red teaming vulnerability probes. The vulnerability probes will assist in determining how effective the protocols are and if alternatives need to be established. Stakeholders should consider employing the use of systems thinking and red teaming to identify vulnerabilities and reinforce the integrity of the U.S. electoral system.

Keywords: election integrity, election security, red teaming, systems thinking, U.S. Secret Service, Department of Homeland Security, DHS, Department of Defense, U.S. electoral system, voting machines, voter registration databases, election management bodies, Cybersecurity and Infrastructure Security Agency, CISA, vulnerabilities, technology, election infrastructure, voter confidence, democracy, voter fraud, election day, cyber attacks, poll workers, voting systems, security plan, advance work, resilient and secure

A PROBLEM OF DEFINITION: CONSIDERATIONS FOR RECATEGORIZING DOMESTIC TERRORISTS

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In the past five years, the United States has seen a noticeable increase in racially, ethically motivated violent extremist (REMVE) activity. By examining the relevance of defining terrorism as international or domestic, this thesis identifies antiquated assumptions that have hindered the U.S. federal approach to investigating and prosecuting REMVE organizations. It also explores whether U.S. legal and judicial frameworks are adaptive enough to address emerging REMVE trends and how the homeland security enterprise can better mitigate and respond to the threat. Using case study analysis to explore the Atomwaffen Division and the Base—two accelerationist, white, ethno-nationalist groups with transnational ties—the thesis documents the emerging trend of REMVE actors, their ideology and motivation, and the digital and transnational context of their activity. The thesis also delves into the ways the First and Fourth Amendments shape the investigation and prosecution of violent extremists, and how the application to domestic and international terrorism varies, as defined in 18 U.S.C. §2331. Homegrown violent extremist organizations can no longer be automatically classified as domestic terrorists. In cases where transnational links exist, the homeland security enterprise should leverage the same tools that have been applied to international terrorist threats such as al-Qaida.

Keywords: racially, ethnically motivated violent extremism; REMVE; domestic terrorism; designation

THE NATIONAL GUARD STATE PARTNERSHIP PROGRAM: IMPROVING SECURITY COOPERATION IN COUNTERTERRORISM AND HUMANITARIAN CRISIS RESPONSE

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This thesis assesses the U.S. National Guard State Partnership Program through a review of three partnerships: West Virginia National Guard-Qatar, Colorado National Guard-Jordan, and Massachusetts National Guard-Kenya. The partnerships are first analyzed within a national security and military doctrinal framework for security cooperation in counterterrorism and humanitarian crisis response. Then, they are evaluated based on an academic framework regarding counterterrorism and military humanitarian assistance. The two frameworks provide a holistic picture of the program's efficacy and areas of improvement. This thesis argues that the program, as conducted within the partnerships evaluated, provides an effective means to pursue counterterrorism and humanitarian crisis management security cooperation objectives. The program is successful overall due to the stability and longevity of relationships nurtured within the partnerships, but also for more nuanced reasons that account for the inherent contradictions between providing aid and bilateral assistance. The program can be improved to meet doctrine by diversifying participants in engagements and topics for engagement, in order to better address the complex relationship between terrorism and humanitarian crisis. However, care must be taken to avoid expanding the program unduly in order to avoid incentivizing partner-nation behavior that creates conditions that increase the likelihood of terrorism and humanitarian crises.

Keywords: National Guard Bureau, State Partnership Program, national security, security cooperation, counterterrorism, humanitarian crisis response, humanitarian crisis management, partner building, capacity building, security assistance, Colorado National Guard, Massachusetts National Guard, California National Guard, West Virginia National Guard, Kingdom of Jordan, Kenya, Qatar, Nigeria, terrorism

OASES OF INFLUENCE: GEOPOLITICAL IMPLICATIONS OF CHINA'S ECONOMIC ENGAGEMENT WITH THE ARAB WORLD

This paper has been recognized as outstanding by its department.

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This thesis examines the political and security implications of China's economic expansion into the Middle East/North Africa (MENA) region. It employs a comparative case study method to assess the PRC's relations with three Arab states: Saudi Arabia, which is a major source of China's petroleum imports; Egypt, which is a significant destination for Chinese infrastructure development resources and a participant in China's Belt and Road Initiative (BRI); and Jordan, which has relatively weak economic ties with the PRC. This research broadly encompasses the period between 1993, the year of China's emergence in the MENA region as a net energy importer, and the present. Ultimately, this thesis finds that China's increasing levels of regional economic engagement are linked with political responses from certain Arab governments. China's economic activities have not induced a shift in partner states' voting behavior as it specifically relates to human rights in the United Nations General Assembly (UNGA). It has, however, influenced the Saudi Arabian and Egyptian governments to respond domestically and internationally to China's Uyghur situation in ways that align with Chinese Communist Party (CCP) interests. It is also correlated with the weakening of the political and security partnership between Egypt and the United States. As such, this analysis suggests that China's regional economic engagement may be having effects on the broader international order.

Keywords: China, Middle East, Sino-Saudi, Sino-Egyptian, Sino-Jordanian, BRI, Belt and Road Initiative, infrastructure development, energy security, influence, United Nations, human rights, Uyghur, U.S. hegemony, international institutions, liberal order, MENA, Middle East/North Africa region, PRC, People's Republic of China, UNGA, United Nations General Assembly, CCP, Chinese Communist Party,

DUAL DISRUPTIONS: OVERCOMING THE EFFECTS OF DISASTERS AND MIS-, DIS-, AND MAL-INFORMATION ON DEMOCRACIES

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Democracy stands at a critical juncture in the current environment of mis-, dis-, and mal-information spreading in the media ecosystem and intensifying disaster challenges. This thesis examines how democratic governments can maintain legitimacy after a catastrophic disaster in the age of false information. It uses the comparative case study method to evaluate three international catastrophic disaster responses—the 2011 Tōhoku earthquake, tsunami, and nuclear power plant disaster in Japan; the Australian wildfires of 2019–2020; and the COVID-19 response in the United States beginning in 2020—within the frameworks for democratic principles, crisis leadership, sensemaking, and the social production of disasters. This thesis finds that the combination of ineffective disaster response, poor leadership, and false information can undermine socially constructed legitimacy, amplify and intensify existing social divides, and create instability and distrust of the government. This thesis proposes a model of social response to disasters that recommends networked responder actions to uphold democratic institutions and legitimacy when citizens have been affected by chaos and uncertainty in the operational and information environments. It recommends building trust and resilient communities through sensemaking, meaning-making, adaptation, community stabilization, and ethics and equity.

Keywords: disaster, crisis, misinformation, disinformation, legitimacy, ethics, democracy, international, social media, resilience, vulnerability, equity, sensemaking, meaning-making, community, adaptation

THE DRAGON'S FOOTPRINT: A STUDY OF HOW REGIONAL INSTITUTIONS RESPOND TO CHINESE INFLUENCE

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This thesis examines how the African Union (AU) and the Association of Southeast Asian Nations (ASEAN) have responded to China's attempts to enhance its regional influence in Africa and Southeast Asia. I conclude that the AU is a weak institution because it lacks financial resources and management capacity to enforce desired regional norms. The thesis also finds that because of these shortcomings, China exercises a greater degree of influence in the AU. Additionally, China has set up the Forum on China-Africa Cooperation (FOCAC) to operate as a competing framework for the region. By contrast, I find that ASEAN is a strong institution because it maintains centrality to regional issues and encourages Chinese adherence to regional norms and values. Overall, I determine that China is most successful in gaining influence when its interests align with regional goals for economic prosperity and integration, such as free trade agreements. This study discovers that when China can amplify institutional disunity, it strengthens its position relative to the existing institutions' positions. This thesis demonstrates that China is least successful in exerting influence over a regional institution when that institution has robust mechanisms to enforce regional norms. In addition, when institutional members view China as a regional threat, they are more willing to band together and speak out against unwanted Chinese aggression.

Keywords: China, Association of Southeast Asian Nations, ASEAN, African Union, AU, Forum on China-Africa Cooperation, FOCAC, Southeast Asia, SEA, South China Sea, SCS, regional institutions, influence

TEPID PARTNERS: THE RIO TREATY AND COLLECTIVE INTER-AMERICAN SECURITY

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The Inter-American Treaty of Reciprocal Assistance, also known as the Rio Treaty, is one of the Organization of American States' (OAS) founding agreements. The treaty includes language that provides for collective hemispheric defense, and it has been invoked on multiple occasions. However, Rio Treaty invocations have consistently struggled to generate salient multilateral security cooperation. This thesis hypothesizes, and finds, that the Rio Treaty has been unsuccessful at producing meaningful security cooperation because of repeated misuse by its signatories. To prove the hypothesis, this thesis examines OAS involvement in two regional crises, the 1965 Dominican Civil War and the Falklands/Malvinas War, in search of common themes. In both cases, a treaty signatory executed a fait accompli and then turned to the OAS in need of international legitimacy rather than strategic need. During the Dominican Civil War, the Rio Treaty was not invoked when it likely should have been. As a result, the Inter-American Peace Force (IAPF), which the OAS dispatched in response to the crisis, would remain forever unformalized. Argentina misused the Rio Treaty by invoking it after it had to face the military consequences of a conflict that it instigated with Great Britain. The vastly different OAS response to each case can be explained by vested U.S. interest in each conflict.

Keywords: Rio Treaty, security cooperation, alliance, Inter-American Security System, Organization of American States, OAS, Inter-American Peace Force, IAPF, Dominican Civil War, Falklands, Malvinas, Latin America, Inter-American Treaty of Reciprocal Assistance, IATRA, TIAR

MIND THE DARIEN GAP

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This thesis has a geopolitical focus, establishing U.S. interests and indigenous protectionism as factors that explain why the Darien Gap remains undeveloped. An analysis of U.S. influence on the development of the Darien Gap establishes a correlation between U.S. interests and the progress of constructing the Pan-American Highway and railroad across time and space. Heightened U.S. interest was influenced by the presence of extra-hemispheric threat in the Western Hemisphere and the timing correlated with the construction's progression and obstruction. The lack of extra-hemispheric threat caused the decline of U.S. support for the infrastructure projects that would have otherwise developed the Darien Gap and gave political space and maneuverability for Panamanian indigenous groups to exert their political pressure and prevent the development of the Darien Gap. The research uncovers the amount of political power the Panamanian indigenous groups have in preventing infrastructure developments. In the end, the thesis proves these two hypotheses to be true: U.S. interest in the region and the Panamanian indigenous communities' political power have prevented the development of infrastructure in the Darien Gap.

Keywords: Panama border, Colombia border, Darien Gap, transportation, infrastructure, Pan-American Highway, indigenous

BRANDING THE ENEMY: THE "KHARIJITE" LABEL AND THE LEGITIMATION OF STATE POWER

This paper has been recognized as outstanding by its department.

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Within the Islamic world, the religious past often plays a formative role in our understanding of contemporary issues. One such rhetorical idiom from the past, the label "Kharijite," has been, and is still, used as a pejorative by both state and non-state actors against myriad Islamist organizations and entities. Through an intensively researched description of historical, religious, and contemporary literature, this thesis examines the historical origins of the ancient Kharijite narrative and the manner in which the historical precedence of the term and its associated imagery have been applied to recent history. Research indicates that the Kharijite label has been used as and remains a legitimizing instrument with the power to imbue its user with Islamic credentials and authority while marginalizing opposition movements. As exemplified in post-colonial Egypt, states use the Kharijite epithet during periods of state formation or weak government rule to solidify the state's monopoly of the use of violence within an Islamic context. Similarly, non-state actors use the charge to create political and religious legitimacy for their movement to the detriment of rival factions. This common utilization of the Kharijite epithet by both state and non-state actors demonstrates the political power of the Islamic lexicon and underscores the legitimacy crisis of nascent regimes and the potential risk for Western states that support regimes who employ the "Kharijite" epithet.

Keywords: Kharijite, Islamic extremism, Political Islam, Islamic State, Muslim Brotherhood, Islam, Islamism, Weber, Egypt, Nasser, al-Hudaybi, Qutb, al-Qaradawi

THE CASE FOR AFFIRMING DIVERSITY: REFLECTIVE RECRUITMENT THAT REPRESENTS THE COMMUNITY SERVED

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Fitchburg Fire Department's (FFD) membership today is not diverse, primarily because the department has experienced limited success in recruiting motivated, diverse firefighter candidates. This thesis poses the following research questions: What can be done to identify current barriers that discourage or hamper reflective recruitment in FFD? And what can be done to overcome recruitment obstacles? The research relied on a focus group composed of Fitchburg-area civic leaders who could share a historical perspective, discuss operational and systematic bias, and consider solutions through reflective recruitment and targeted community outreach. The group's recommendations were incorporated into a plan that involved short-, medium-, and long-term recruitment outreach and recruitment goals over a two-year timeline. The group identified potential school programs, racially centric groups, and current FFD membership that can positively influence prospective firefighter candidates. Recognizing that professional standards need not be compromised in the pursuit of a more representative workforce, the focus group recommended intentional acts of inclusion to stimulate occupational and organizational interest. This thesis finds that if FFD aims to recruit a workforce that resembles the community served, inclusivity will depend largely on targeted neighborhood outreach, a form of affirmative action.

Keywords: diversity, recruitment, community representation, reflective workforce, employment outreach, talent, competency, skills, mentoring, assimilation, teamwork, fire service culture, culture, training, development, technical education, STEM, athletics, athletes, partnerships, Fitchburg Fire Department, FFD

NAVAL DIPLOMACY IN LATIN AMERICA: THE INFLUENCE OF PORT VISITS

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This thesis examines the port visits of two U.S. naval deployments to Latin America (USS *America* [LHA 6] in 2014 and the USS *Gunston Hall* [LSD 44] in 2018) to find what strategic effects the United States is achieving through this aspect of naval diplomacy. Using an original framework, the study compares primary Latin American news sources to U.S. press releases that cover the visits to identify influence and relates those findings to bilateral relationships, theater objectives, and routine operational activities. Overall, the United States is attaining positive diplomatic influence through the use of port calls; however, there is room for improvement and the Navy's approach can be optimized to better achieve effects in support of strategic regional objectives. Particularly, matching U.S. actions and events in-port to overall U.S. security policies and enlisting the support of the relevant U.S. embassies can increase the opportunities and likelihood of success in acquiring influence. Attaining U.S. soft power through naval diplomacy in Latin America will only continue to grow in importance with the return to great power competition and the need to counter the encroachment of Chinese influence throughout the region.

Keywords: naval diplomacy, gunboat diplomacy, naval presence, influence, soft power, port visits

REALIZING RESILIENCE: A STUDY OF DEFINITION, INDICATORS, AND OPERATIONALIZATION

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Resilience is a term ubiquitously used to gauge how communities fare during and following disasters. Academics and practitioners see resilience as a critical driver of a community's success or failure in recovering or bouncing back from disasters. This thesis aims to provide insight into improving resilience by bridging how it is studied in theory and practiced in the field. This thesis examines resilience in the literature and presents four case studies, which focus on resilience governance and social, physical, and economic resilience indicators. The findings of this thesis show the necessity of community cohesion in growing a community's resilience. The cases also show the benefit of clear resilience governance frameworks rooted in diverse, equitable leadership that represents the communities served. Moreover, fostering individual resilience contributes to a community's resilience level. Finally, the term resilience needs both reconceptualizing and reimagining in a way that better aligns with current-day challenges.

Keywords: resilience, community resilience, disaster studies, disaster studies, recovery, academic and practitioner, case studies, 100 resilient cities, earthquake, vulnerable, adaptation

NCAA FOOTBALL GAME SECURITY IN THE BIG TEN CONFERENCE: HOW CAMPUS POLICE ARE TRAINED AND EQUIPPED TO COMBAT TERRORISM

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Second Reader: Erik J. Dahl, Department of National Security Affairs

College football stadiums in the Big Ten Conference can host 100,000 fans each home game, which make them potential targets for terrorists or lone wolves who seek to further their agenda through mass casualty events. This thesis answers the following question: How do campus police in the Big Ten Conference protect football stadiums against potential terrorist attacks and coordinate with outside agencies to ensure crowd security without sacrificing the fans' experience? Using a multi-level analysis of the campus and stadium environment, this thesis identifies the different threats and complexities that beset the campus environment and how campus police utilize their resources to defend the football stadium environment. Additionally, this thesis draws comparisons to the security operations of the National Football League, specifically its use of common standards of security across all teams. Universities in the Big Ten have too many disparities between each stadium's security operation, which could lead to potential gaps in the future. This thesis concludes that mandatory reporting of pre-existing mental health conditions and creating common standards for stadium security will alleviate the disparities between each university and fill latent security gaps.

Keywords: NCAA football, National Collegiate Athletic Association, campus police, campus police failings, terrorism, campus threats, professionalized, Big Ten Conference, Department of Homeland Security, football stadium, community policing, intelligence-led policing, jurisdiction, mental health, collaboration, stadium security, coordination, National Football League, NFL

MONITORING THE UNPREDICTABLE: WHAT CAN LAW ENFORCEMENT DO TO TRACK POTENTIAL ACTIVE SHOOTERS?

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Since the late 1990s, few incidents have captured the national spotlight more than active shooter events. These events are a significant concern to the public, and as questions arise surrounding these incidents, the focus often turns to law enforcement and its ability to protect the public. Often, law enforcement's response to inquiries surrounding prevention strategies concludes with officials explaining that they did everything possible to prevent the attack. This thesis analyzes the history of active shooter response and examines why law enforcement focuses more on response management than on prevention strategies. The project identifies issues when law enforcement, regardless of size or allocated resources, fails to establish a plan to track and monitor potential active shooter threats. Comparing four case studies—the Marjory Stoneman Douglas school shooting, Virginia Tech incident, Odessa-Midland attack, and the 1 October Las Vegas mass shooting—the research aims to identify investigative gaps that may have helped prevent the attacks. It categorizes the probability of preventing attacks based on available resources to law enforcement. The conclusion points to gaps with information sharing, planning, and resource allocation that could help agencies prepare for any future attacks.

Keywords: monitor, active shooter, tracking, potential active shooter

NATO'S INTERVENTION IN LIBYA: THE POLITICAL REASONING BEHIND NATO'S INTERVENTION

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This thesis examines the political reasoning behind the decisions of the United States, the United Kingdom, and France to get involved in an intervention in Libya and their ultimate desire to ask the North Atlantic Treaty Organization (NATO) to get involved. The political reasoning for the three countries' decisions varied from wanting to obtain political capital in an election year to wanting to avoid a humanitarian crisis, especially in a location so close to Europe's southern border. NATO had its own political reasoning for its involvement, which included the desire to prevent the alliance from fracturing in a time of defense cuts and to prevent coalitions from forming that could undermine the long-term health of the alliance.

Keywords: North Atlantic Treaty Organization, NATO, Libya

IDENTIFYING ASSETS TO INCREASE MARITIME BORDER SECURITY

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As increased border security measures are adopted along the United States' southern land border, researchers believe that an increase in illicit maritime traffic can be expected. As the primary maritime security agency, the U.S. Coast Guard (USCG) is suffering from a lack of interdiction assets and resources and admits it is already only capable of responding to one-third of all known maritime smuggling events. Based on current data regarding drug interdictions within the maritime domain and the expectation that smuggling events will increase, can the number of successful interdictions be increased through greater interoperability and cooperation between the U.S. Navy (USN) and USCG? This thesis discusses the mission of both the USN and USCG and analyzes the role that Joint Interagency Task Force South (JIATF South) plays in coordinating counter-narcotics efforts. The research for this thesis suggests that JIATF South is successfully coordinating responsibilities among all involved agencies to maintain complete awareness of maritime drug smuggling, but that it now lacks the necessary assets to improve on the number of successful interdictions each year. The USN is aiming to surpass the previous goal of a 355-ship fleet by developing unmanned surface vehicles, which could prove to be the asset JIATF South needs.

Keywords: U.S. Coast Guard, USCG, U.S. Navy, USN, autonomous systems, unmanned surface vehicles, USV, maritime security, border security, maritime border security, JIATF South, Joint Interagency Task Force South

THE INFLUENCE OF ANTI-SEMITIC IMAGERY AND RHETORIC IN GERMANY DURING THE EARLY TO MID-20TH CENTURY

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Propaganda imagery and rhetoric has played a role in mass persuasion leading to an escalation of political violence connected to ethnic hatred as found in Germany in the 20th century—and beyond. By examining the anti-Semitic rhetoric and imagery used in Nazi Germany, this study examines the propaganda of racial hatred as a mechanism for gaining domestic political power—and then for launching a systematic strategy of mass-murder of Europe's Jews. While the Nazis employed the most modern means available to disseminate their anti-Semitic propaganda, the message resonated with the long-standing and deep-seated hatred of Jews in Germany and Europe. Both the ideas and the methods continue to influence right-wing extremism today in Germany and elsewhere; as such, this study revisits the origins and effects of anti-Jewish propaganda in the Third Reich with an eye toward the continuing relevance of this analysis.

Keywords: Nazi, propaganda, anti-Semitism, imagery, rhetoric

IF YOU LOVE THEM, LET THEM GO: A COMPARATIVE ANALYSIS OF ROTATIONAL PROGRAMS AND RECOMMENDATIONS FOR THE HOMELAND SECURITY ENTERPRISE

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Rotational programs—whereby employees temporarily work within a different part of an organization to gain new skills and knowledge—have become the rage across the country. Benefits of these programs in the private sector include continual learning, agility in job skills, and a "try before you buy" approach to job satisfaction for both the employee and employer. The Department of Homeland Security (DHS) has implemented two rotational programs; however, these initiatives are in the early stages of implementation, and their effectiveness remains unclear. To identify opportunities for optimization, this thesis draws upon the work of Campion and Griffiths to analyze case studies from mature federal rotational programs within the Department of Defense and the Intelligence Community and determines the benefits and challenges of each. Based on these findings, it investigates to what degree DHS can leverage best practices from these programs to strengthen its workforce, augment the effectiveness of the program design, and fulfill the mission of the programs. Ultimately, DHS has opportunities to improve on key elements, such as inclusivity, encouraging participation through credits and incentives, ensuring a strong foundation for the program, and developing a continual review process through metrics, data collection, and review.

Keywords: rotational assignments, professional development, government, Department of Homeland Security, DHS

THE RUSSIAN FEDERATION'S USE OF NON-STATE ACTORS IN HYBRID OPERATIONS IN EUROPE

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Second Reader: Tor Bukkvoll, Norwegian Defence Research Establishment

Under what circumstances is Russia successful in waging hybrid operations, short of the use of armed force? For the last two decades, Russia has undertaken structured cyber attacks, political destabilization, subversive activities, and psychological influence throughout the world as part of what has become known as "hybrid warfare" or "New-Type War" (NTW).This thesis examines two contemporary European case studies—Estonia and Montenegro—where Russia has used indirect means such as proxy forces, organized crime, and other tools to conduct influence operations in its attempts to achieve its foreign policy goals. The thesis investigates how Russia has used, or tried to use, these non-state actors; how effective these operations have been; and whether Russia was successful in reaching its foreign-policy objectives in target states. The thesis finds that Russian NTW campaigns require that there be no cohesive society in the target country. Contradictions and a divided society in the target country are the basis on which Russia can build an NTW campaign and choose the elements of NTW—non-state actors—to carry out the campaign. Thus, the most crucial aspect of launching and conducting an NTW campaign is the psychological influencing and so-called unbalancing of the target country's society and government.

Keywords: Russia, hybrid, New-Type Warfare, NTW, non-state actors, near-abroad, influence

DRIVERS OF CHINA'S ENERGY SECURITY

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This thesis studied China's energy security policies' primary drivers and, more specifically, how China acquires the energy needed to satisfy its social and economic needs. This thesis examined three primary drivers of China's energy security policies: the diversification of resources due to foreign pressures, the development of green energy, and the increase in growth and urbanization. After systematic analysis, this thesis found that China has not achieved energy independence because of an increase in growth and urbanization and heavily relies on imports to meet demands. China primarily relies on coal to fulfill its demand and lacks the domestic capability to meet its oil and natural gas demands. Air pollution and climate change are the primary motivators for China's green energy policies, prompting China to develop modern technology in the renewable energy sector to reduce air pollution, making it the global leader in the sector. China diversifies its energy security portfolio to avoid geostrategic risks to the energy mix, such as the Malacca dilemma and uncertainty with the Strait of Hormuz. China is dependent on Australia for natural gas and on the Middle East for oil imports. China seeks to secure access to resources via pipelines from Central Asia and Russia to avoid security issues in the Strait of Malacca and the Strait of Hormuz.

Keywords: China, energy security, foreign reliance, green energy, diversification of resources

SAVING OUR OWN: MAXIMIZING CBRN URBAN SEARCH AND RESCUE CAPABILITIES TO SUPPORT CIVIL AUTHORITIES

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This thesis seeks to determine how the Chemical Biological Radiological Nuclear (CBRN) Response Enterprise's urban search and rescue (US&R) elements can better accomplish the Department of Defense's (DOD) Defense Support of Civil Authorities mission following a domestic nuclear attack. To this end, it poses the following research question: How can the DOD maximize the employment of existing CBRN Response Enterprise US&R capabilities to support civil authority–directed lifesaving efforts following a domestic nuclear detonation? Research interviews were conducted with federal and local civil US&R authorities that inquired about their expectations of enterprise US&R elements after a nuclear detonation. Additionally, an analysis was conducted of the enterprise's ability to overcome the challenges presented by post-nuclear detonation environments when delivering this support. It was discovered that federal civil US&R authorities intend to use the CBRN Response Enterprise's US&R elements as force multipliers, while local authorities have more ambiguous expectations since they receive far less exposure to the enterprise's US&R capabilities. Furthermore, to improve the delivery of life-saving aid, the enterprise should enhance its capabilities to address the threat of fire and added challenges to the performance of US&R skills incurred by post-nuclear detonation environments.

Keywords: urban search and rescue, urban search & rescue, USAR, US&R, chemical biological radiological nuclear, CBRN, technical rescue, nuclear detonation, CBRN Response Enterprise, post-nuclear detonation environment, structural collapse, search and rescue, SAR, CBRNE Enhanced Response Force Package, CERFP, Defense CBRN Response Force, DCRF, United States Northern Command, USNORTHCOM, NORTHCOM, National Guard Bureau, NGB, National US&R Response System, Defense Support of Civil Authorities, DSCA

WHY WE SERVE: PUBLIC SERVICE MOTIVATION AND WHAT THE USCIS MISSION MEANS TO ITS WORKFORCE

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Co-Advisor: Christopher Bellavita (contractor), Center for Homeland Defense and Security

Why do people choose to serve with the United States Citizenship and Immigration Services (USCIS)? How has USCIS articulated its mission and organizational values since its creation? What mission values do employees believe in versus what USCIS asks of them? This thesis uses public service motivation (PSM) theory and value congruence theory to interpret the alignment of USCIS employee value perceptions with organizational values from 2015 to 2020. An examination of the USCIS mission from 2003 to 2020 equips the reader with a comprehensive picture of its evolution. A qualitative analysis of USCIS employee motivational survey responses captured from 2015 to 2020 provides visibility into employee perceptions of "why we serve." The PSM themes found within employee responses—compassionate humanitarian, public interest servant, upholder and influencer of policy, self-sacrificing public servant—provide insight into employee role perceptions. Research findings found a strong fit between organization and employee before 2018. After a substantial change in USCIS mission values in 2018, the fit between the compassionate humanitarian and the organization wanes. However, other PSM values emerge in employee PSM values, suggesting that the organizational storyline may influence individual perception over time. A call for further research is encouraged for sense-making exercises with the Cynefin framework, post-2020 employee PSM perceptions, and employee retention and organizational fit.

Keywords: homeland security, public service motivation, mission statement, organizational storytelling, individual perspective, Cynefin framework, USCIS, RAIO, value congruence, policy change

STEPPING OUT OF THE SHADOWS: LEVERAGING THE COMMUNITY TO STOP THE SEXUAL EXPLOITATION OF MINORS

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The online transmission of child pornography has exploded in recent years, and law enforcement does not have the resources to stop it. This thesis seeks to determine the advantages and disadvantages of using citizen volunteers to help investigate child sexual abuse material (CSAM). Specifically, it investigates whether incorporating civilians into certain aspects of CSAM investigations could assist law enforcement in filling gaps in resources needed to ensure all recovered images be fully investigated in less time. To test the hypothesis that creating opportunities for civilians to assist law enforcement will positively impact law enforcement's ability to investigate CSAM offenses, this thesis uses policy analysis to compare three policy-option alternatives. The results confirm the hypothesis by demonstrating that incorporating skilled civilian volunteers into a national volunteer program is an effective option to assist law enforcement in CSAM investigations. These results suggest law enforcement and policy makers should establish a national volunteer program that allows skilled volunteers to assist law enforcement agencies around the nation in certain time-consuming or technically complex aspects of investigations. Doing so opens up resources to law enforcement agencies and provides much-needed assistance to investigators while allowing volunteers meaningful opportunities to use their skills and time to combat the sexual exploitation of children.

Keywords: CSAM, child sexual abuse material, volunteers, crowd sourcing, open-source investigative techniques, OSINT

FIRE WHEN READY: A NEEDS-BASED ANALYSIS OF FIREARMS IN THE U.S. FIRE SECTOR

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Recent active shooter incidents and other on-the-job violent encounters have caused U.S. fire departments to consider arming their personnel. Since governmental bodies and safety agencies have failed to establish firearms-use guidelines within the fire sector, many fire service decision-makers have arbitrarily adopted gun carry policies. This thesis investigates the most relevant factors such as firearms program costs, gun training concerns, and safety agency positions on firearms for the U.S. fire sector to consider when establishing firearms programs and employs a comparative options analysis methodology. Issues surrounding proper training in gun use and gun storage, the lack of safety agency guidance, and conflicting gun policy attitudes are some of the crucial elements addressed. This work evaluates the Department of Public Service (DPS), Tactical Fire Team (TFT), and conceal carry programs, which can be leveraged by fire stakeholders to make informed decisions as they consider including firearms in their operational models. Finally, this study concludes that departments should fashion firearms programs in the image of established armed teacher programs, which have yielded the most robust safety records and that the National Fire Protection Agency (NFPA) should be assigned to set standards for a full suite of safe gun practices. Moreover, if properly motivated, the federal government can enact one national firearms policy for fire service members.

Keywords: firearms, fire service, gun policies, fire safety organizations, concealed carry permits, tactical fire teams, Law Enforcement Officer Safety Act, comparative options analysis, armed educators, gun security issues, Department of Public Safety, DPS, Tactical Fire Team, TFT, National Fire Protection Agency, NFPA

MASTER OF BUSINESS ADMINISTRATION

A PLAN FOR ACTION: HOW THE DOD BEGINS SYSTEMATICALLY ADDRESSING THE HOUSING FAILURES OF TODAY TO PRESERVE THE NATIONAL DEFENSE OF TOMORROW

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Master of Business Administration
Advisor: Robert J. Eger III, Graduate School of Defense Management
Second Reader: Ryan S. Sullivan, Graduate School of Defense Management

Military family housing programs are in crisis, the product of a policy-strategy mismatch resulting from competing interests among the United States Congress, Department of Defense, private real-estate developers, and the military members and families who rely on military housing. Through a policy-centered literature review, survey instrument, and analysis, this thesis investigates the mismatch and its impacts on military member and family health and readiness. Responses to this study's survey and research sample suggest that few differences exist between respondents of military family housing and residents of local civilian community housing, with the most significant supported finding being that military housing respondents' air-filtration maintenance occurs less often than that of local community housing. The overall findings suggest that the survey instrument, with minor improvements, could be used to acquire accurate and actionable data related to occupant health, well-being, and readiness, with the intrinsic benefit of serving as a rubric to gauge achievement of current housing and readiness policies. Succinctly put, the study's survey instrument could easily be used by housing tenants, providers, and support staff as a near-definitive physical inspection diagnostic tool to identify physically observable indicators and building assemblage characteristics commonly observed, known, and associated with unsafe and unhealthy housing conditions.

Keywords: military family housing, affordable, quality, safe, health, healthy, habitable, uninhabitable, well-being, readiness, lethality, agility, reform, tenant, resident, satisfaction, policy, procedures, authority, objective, priority, strategy

ALL ABOARD! BENCHMARKING HUMAN RESOURCES ONBOARDING PRACTICES – PART II

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Co-Advisor: Anita M. Salem, GSDM Program Office

This research builds on the work of Helene Caniac's Naval Postgraduate School thesis "All Aboard! Benchmarking Human Resources Onboarding Practices," by assessing current Department of the Navy (DON) onboarding practices of Navy civilian executives and providing recommended human resource solutions to support the onboarding of those executives. This research analyzes the onboarding of leaders within organizations through interviews of subject-matter experts and the application of an onboarding model, which was developed using data in Part I of the research. Practices in the onboarding model can assist the Navy in improving leadership development, which has been neglected according to Office of Personnel Management studies. This thesis argues the "Executive Onboarding Activities" model provides a focus toward improving and standardizing Navy civilian executive leadership development with transformative organizational goals and relational onboarding activities. The analysis of interview data reveals that several gaps exist in the onboarding activities of Navy civilian executives. These and other gaps are supported by examining current DON and Department of Defense executive development programs against the onboarding model. Overall, this study finds that in addition to connecting executive onboarding to leadership development, addressing several gaps will support the assimilation and development of Navy executives.

Keywords: Onboarding, leadership, SES, human resources, HR, training, development, civilian, senior executive service, Navy, OPM, government, executive development, leadership development, Navy civilian leadership, executive onboarding, onboarding practices, OCHR, Office of Civilian Human Resources, EMPO, Executive Management Program Office

MASTER OF SCIENCE

Computer Science
Cyber Systems and Operations
Electrical Engineering
Management
Mechanical Engineering
Meteorology and Physical Oceanography
Network Operations and Technology
Operations Research
Space Systems Operations
Systems Engineering

NPS
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MASTER OF SCIENCE IN COMPUTER SCIENCE

USER IDENTIFICATION IN DYNAMIC WEB TRAFFIC VIA DEEP TEMPORAL FEATURES

This paper has been recognized as outstanding by its department.

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Second Reader: John D. Fulp, Department of Computer Science

Web applications that process sensitive information have become prevalent. Modern web applications rely heavily on dynamic content (i.e., page updates made by the browser using an XMLHttpRequest, and more recently the JavaScript Fetch API). Ajax technology provides fast client-server communication, which generates web traffic that updates the document object model (DOM) object in the browser interface often induced by user input. Therefore, the user's actions are strongly correlated with timing and size of packets that carry Ajax requests. This research aims to characterize the relationship between keystroke dynamics and Ajax packets in dynamic web traffic. We investigate several dynamic web applications and the ability to measure human behavior in encrypted network traffic. Two approaches to Ajax packet detection are proposed and evaluated: longest increasing subsequence (LIS), which uses packet sizes, and dynamic time warping (DTW), which uses keystroke and packet timings. From the detected packets of recognized patterns, we examine the extent to which remote user identification in dynamic web traffic can be performed. We use a recurrent neural network (RNN) trained with triplet loss to extract deep temporal features from the detected packet timings. Leveraging recent work in keystroke dynamics, we show that user identification can be performed with modest accuracy utilizing the packet timings invoked by a user typing in a web search engine.

Keywords: network traffic analysis, keystroke biometrics, dynamic web traffic, side channel attack, recurrent neural network, triplet loss, user identification

DESIGN AND IMPLEMENTATION OF A DISTRIBUTED LEDGER TO SUPPORT DATA SURVIVABILITY IN AN UNMANNED MULTI-VEHICLE SYSTEM

This paper has been recognized as outstanding by its department.

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Co-Advisor: Duane T. Davis, Department of Computer Science

Autonomous vehicle systems, including multi-vehicle systems, are becoming increasingly relevant in military operations. A problem emerges, however, when logging data within these systems. In particular, loss of individual vehicles and inherently lossy and noisy communications environments can result in the loss of important mission data. This thesis presents a novel distributed ledger protocol that can be used to ensure that the data in such a system survives. To test the efficacy of the protocol, we implemented it as a Robot Operating System (ROS) node on the Advanced Robotic Systems Engineering Laboratory (ARSENL) aerial swarm system.

Results are presented for implementation tests in the ARSENL software-in-the-loop simulation environment and during live-flight field experiments conducted at Camp Roberts, CA.

Keywords: distributed ledger, blockchain, unmanned aerial vehicle, UAV, unmanned vehicle system, UVS, Advanced Robotic Systems Engineering Laboratory, ARSENL

AUTONOMOUS SYSTEM CHOKE POINTS IN COUNTRY-LEVEL NETWORK TOPOLOGY

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Internet traffic choke points within country-level logical networks exist at the Autonomous System (AS) level, with consequences and implications for country-level network topology and vulnerability to network disruption or surveillance. This thesis introduces the concept of such "Gateway ASs," which serve to connect the logical interior of a given country's network to the larger internet and further demonstrates it to be a well-defined and useful concept. By fully characterizing the prevalence and nature of these Gateway ASes across the internet as a whole, this study demonstrates that the internet remains highly hierarchical at the country level, despite the internet's evolutionary trend toward a "flattened" topology. Furthermore, this conception and characterization of country-level network topology is leveraged to map vast portions of the logical internet landscape to physical country borders but ultimately fails to provide an accurate and complete heuristic for internet infrastructure geolocation based upon logical AS classification. Finally, this study provides an assessment of the country's most susceptible-to-censorship events based upon the structure of their network topology and quantifies an upper bound (by percentage of available Internet Protocol (IP) space within the geographic confines of the country) for the effectiveness of such censorship schemes to fully sever network connectivity with the larger internet.

Keywords: networking, autonomous systems, internet censorship, internet topology, border gateway protocol

MASTER OF SCIENCE IN CYBER SYSTEMS AND OPERATIONS

SAFETY ENGINEERING OF WEAPONIZED AUTONOMOUS SYSTEMS

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Co-Advisor: Loren E. Peitso, Department of Computer Science

This capstone explores the applicability of the Systems-Theoretic Accident Model and Processes (STAMP) framework and the System-Theoretic Process Analysis (STPA) methodology to guide consideration of system safety concerns posed by future variants of Sea Hunter. The author analyzed the Sea Hunter's navigational mission behaviors from a high-level perspective of a functional hierarchy, discussing the specific steps of how basic STAMP/STPA can be used to identify safety hazards and safety hazard casual factors on a complex system such as Sea Hunter. Using the STAMP/STPA methodology, the author provides a functional hierarchy example of the potential system safety hazards involved on the different hierarchy levels in the steering system on Sea Hunter. This capstone discusses how STAMP/STPA can be used to identify system-level hazards, identify unsafe control actions, and identify loss scenarios in the example. The U.S. Navy needs to ensure that its assessment capabilities can be used to adequately identify and evaluate safety hazards, safety hazard causal factors, safety controls, and safety risks of autonomous weapons systems (AWS). AWSs are defined as weapons that can independently select and attack targets. STAMP/STPA is a promising approach to safety analysis; further examination of its applicability and utility in the context of AWS is recommended. If beneficial, this toolset could help the U.S. Navy accelerate the development of fully autonomous technology.

Keywords: safety, autonomous weapon systems, STAMP, STPA

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MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

REFINING DEEP LEARNING NEURAL NETWORKS FOR AUTONOMOUS VEHICLE NAVIGATION

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Co-Advisor: James Calusdian, Department of Electrical and Computer Engineering

Machine learning methods have recently increased in appearance in navigation and guidance applications by means of image classification. This thesis sought to advance the ongoing Electrical and Computer Engineering (ECE) Control Systems and Robotics Laboratory project in developing a system that will autonomously navigate across the Naval Postgraduate School (NPS) campus. In pursuit of providing a robust navigation and guidance solution to an autonomous robotic vehicle, a convolutional neural network (CNN) was trained to classify significant objects around NPS. In addition to increasing the number of objects that the neural network could classify, the network was also trained with varying image augmentation techniques applied to the training and validation images. A variety of tests were performed to evaluate the accuracy of the model when exposed to different objects and regions throughout the campus. The tests also included running the image classification model against images that were altered with crop, blur, rotation, and noise. The results demonstrated high classification accuracy and asserted that the output was robust when faced with poor image quality. This work established a strong baseline for more CNN output integration into the navigation and guidance solution of the robotic vehicle.

Keywords: navigation, autonomy, machine learning, neural networks, CNN, robotics

APPLICATION OF ALGORITHM LEARNING TO IDENTIFY AND MITIGATE CONCEPT DRIFT

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Second Reader: James W. Scrofani, Department of Electrical and Computer Engineering

Data streams are becoming more numerous and complex, driven by an increased number of capable sensors. The complex, highly dimensional datasets created by these sensors contain information critical to our understanding of the battlefield situation. A significant change in the adversary's tactics, techniques, and procedures (TTPs) leads to a shift in the collected sensor data. The shift in the distribution of features in the data stream is known as concept drift, and this drift can be detected through predictive machine learning. We propose a novel drift detection method, named Reduced Dimensionality Drift Detection (RD3), based on dimensionality reduction to decrease feature space through supervised learning and unsupervised detection. Additionally, we show that concept drift can be mitigated after detection via an automated algorithm. We validate the performance of our novel method through comparison to a proven detection method, in similar trials and conditions, and show that RD3 performs comparably in concept drift detection and mitigation in all datasets evaluated.

Keywords: concept drift, drift detection, ensemble learning, adaptive learning, classification, supervised learning, unsupervised learning, TTPs, Reduced Dimensionality Drift Detection, RD3

PERFORMANCE ANALYSIS OF AN UNMANNED SYSTEMS COMMUNICATIONS NETWORK USING DATA DISTRIBUTION SERVICE IN A LOSSY ENVIRONMENT

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The Ship Integration Program Office (PMW760) is interested in the prospect of having a unified, cohesive communications protocol that can be used by all unmanned systems under their purview. The Data Distribution Service (DDS) is a prime candidate for such cohesive communications using point-to-point links. The objective of this thesis is to assess the performance of DDS in a network architecture that fits the naval use case criteria. We propose a network architecture that incorporates Satellite Communications (SATCOM) and Wireless Fidelity (WiFi) links to test the ability of DDS to execute cohesive communications between the network nodes within constraints of the scenario setup. We use a network emulator, Mininet, to set up the network parameters and investigate the throughput and latency performance of the individual point-to-point links across various data sample sizes. Simulations are conducted to measure throughput and latency under different network configurations (Ideal, Jitter and Multi-Flow) using the Real-Time Innovation Perftest software tool. For the Ideal and Jitter configurations, the simulations are performed for RELIABLE and BEST EFFORT communications as well as with and without implementation of DDS security. We also conduct simulations in the Multi-Flow configurations to evaluate how simultaneous multi-flow data (traffic data running in parallel within the network nodes) contend for the network resources and impact performance.

Keywords: DDS, Mininet, SATCOM, WiFi, throughput, latency, unmanned systems

IDENTIFICATION AND CLASSIFICATION OF SIGNALS USING GENERATIVE ADVERSARIAL NETWORKS

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Research has shown that machine learning holds promise as a technique to improve the identification and classification of signals of interest. This study proposes the use of machine learning, specifically generative adversarial networks, to classify received signals based on their down-converted, but not demodulated, in-phase and quadrature signals and evaluate their probability of being of interest. The approach used a generative adversarial network to train a classifier convolutional neural network to determine the likelihood that a received signal is of interest. We tested the ability of a semi-supervised generative adversarial network to classify signals of interest by modulation scheme. We then tested the ability of the semi-supervised generative adversarial network to identify unique signals of interest within a dataset of a single modulation scheme. We evaluated the performance of the network on accuracy, training time, and the amount of data needed to train the network. The results proved that a semi-supervised generative adversarial network could classify a signal by modulation scheme and identify signals within a single modulation scheme.

Keywords: generative adversarial network, neural network, deep learning

POSITION ESTIMATE FIDELITY FROM TAG MULTILATERATION ATTACK WITHIN THE 5G ENVIRONMENT

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The advent of 5G promises a new age of speed and connectivity of mobile devices. Location-based services will reach a new state of accuracy as well. 4G/LTE implemented the timing advance group (TAG) to increase throughput by allowing user equipment (UE) to connect to multiple base stations (BSs). Timing advance (TA) commands are utilized in order to maintain time synchronization between each servicing BS by directing when the UE should transmit based on the distance to each associated BS. For 4G/LTE, each TA is a multiple of 78.125 meters. As the subcarrier spacing increases in 5G, this distance resolution drops proportionately. These TA commands are sent frequently as the UE moves throughout the environment and are unencrypted. This opens the concern that if an adversary were to collect and correctly associate the TAGs of a specific target, they may be able to ascertain a position estimate using multilateration. The TAG exploit has been examined for 4G/LTE and has been shown to be significant, but the new subcarrier spacing for 5G theoretically will increase the fidelity with which locations can be determined. The focus of this thesis is to establish a Cramér-Rao Lower Bound (CRLB) for position estimates based on the TA commands for each of the 5G sub-carrier spacing and to implement and test an algorithm for finding a position estimate based on target TAs through simulation.

Keywords: 5G, timing advance group, TAG, location privacy, Cramér-Rao Lower Bound, CRLB, user equipment, UE, base stations, BS, timing advance, TA

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MASTER OF SCIENCE IN MANAGEMENT

OVERCOMING BARRIERS: THE IMPACT OF JOB SATISFACTION ON THE RETENTION OF MINORITY OFFICERS

Christopher G. Smith II, Lieutenant, United States Navy
Jude Akpunku Jr., Lieutenant, United States Navy

Master of Science in Management

Advisor: Paul Lester, Graduate School of Defense Management
Co-Advisor: Simona L. Tick, Graduate School of Defense Management

This thesis uses a mixed method approach to evaluate the impact of job satisfaction on the retention of minority officers in the Surface Warfare Officer community. In the context of this study, job satisfaction includes the following components: sense of affiliation, sense of inclusion, need to belong, and perceived organizational support. Using these components, this thesis performs a comparative analysis of survey data from junior officers (O1 to O3) and thematic analysis of twelve interviews from senior officers (O-4 and above) to identify commonly perceived barriers to retaining a diverse workforce. The surveys are developed to measure individual job satisfaction, while the interviews have complementary questions to determine factors affecting retention decisions among various demographic groups. Our analysis identifies sense of affiliation and belonging as components of job satisfaction that remain unmet for minority officers in our sample. Based on these findings, our recommendation is to try to address these job satisfaction components by introducing soft leadership skills at milestone schools, leveraging affinity groups to improve mentorship opportunities and implementing strategies to hold the organization accountable. Although diversity and inclusion efforts have improved, there is still room to enhance the sense of equity throughout the force.

Keywords: inclusion and diversity, retention, manpower

MARINE CORPS MILITARY OCCUPATIONAL SPECIALTY (MOS) ASSIGNMENTS: CAREER IMPACTS OF MATCH QUALITY

This paper has been recognized as outstanding by its department.

John M. Bailey, Major, United States Marine Corps
Master of Science in Management
Advisor: Chad W. Seagren, Graduate School of Defense Management
Co-Advisor: Nicholas Dew, Graduate School of Defense Management

As the Marine Corps confronts a battlefield of increasing scale, complexity, and fluidity, it must leverage every opportunity to optimize performance and lethality. To this end, General David H. Berger, Commandant of the Marine Corps, has prioritized the improvement of talent management practices. However, one concept within talent management, match quality, remains largely overlooked and unexplored. This research explores whether the same economic and social benefits of match quality suggested in the literature also apply in the Marine Corps. As such, this thesis uses regression analysis to determine the statistical relationship between MOS preference received on career outcomes among Marine Corps officers. It also determines factors not currently considered within the Marine Corps' MOS assignment process that may be used to improve Marine Corps officer's occupational specialty match quality. The results of this study indicate a modest, but statistically significant,

relationship between MOS preference received and performance. However, MOS preference is not found to be a positive, statistically significant predictor of length of service. Still, these findings support the establishment of a system that efficiently exchanges information about the individuals and occupations in the market, reveals their true preferences, and improves match quality. This study identifies several realistic and feasible methods to improve match quality within the Marine Corps.

Keywords: talent management, talent assessment, match quality, USMC, TBS, Marine officers, non-cognitive assessment

CORRELATIONS BETWEEN LOCAL HEALTH CONDITIONS AND MILITARY ACCESSIONS

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Advisor: Latika Hartmann, Graduate School of Defense Management
Second Reader: Yu-Chu Shen, Graduate School of Defense Management

This thesis studies the correlation between annual military accessions and local disease burden using county-level data from 2016 to 2019. One of the biggest challenges the military faces today is maintaining a healthy, professional, and strong military appropriately equipped—mentally, physically, and emotionally—to complete assigned missions and tasks. The worsening prevalence of obesity and other underlying diseases in the civilian population significantly affects the total number of successful military accessions each year, primarily due to the U.S. military force consisting of mostly young adults. To better understand how the variations in disease burdens affects military accessions, I measure local disease burdens using health conditions such as obesity, diabetes, mental health, and vision defects, and military accessions for all services at the county level. In my results, I find that the military mainly draws its accessions from unhealthier parts of the United States even after controlling for differences in income and education across counties. Therefore, my findings indicate that the military still draws many of its accessions from parts of the county with worse underlying disease burdens. These findings have important implications for future medical policy design and entry into the U.S. military.

Keywords: accession, Air Force, Army, BMI, diabetes, disqualifying conditions, heart disease, Marine Corps, mental health, Navy, obesity

ASSESSING INCLUSION IN THE FLEET FOR UNDERREPRESENTED GROUPS

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Anthony Caballero, Lieutenant, United States Navy

Master of Science in Management

Advisor: Jeremy A. Arkes, Graduate School of Defense Management
Co-Advisor: Mark E. Nissen, Department of Information Sciences
Second Reader: Erik Helzer, Graduate School of Defense Management

This thesis develops surveys using Likert scales and open-ended questions to measure inclusive behaviors in the Navy. We compared responses across gender and racial/ethnic groups as well as between sailors stationed on the East Coast vs. the West Coast. The survey we created can be used to assess inclusive and exclusive behaviors in the fleet. We examined what inclusion and exclusion behaviors look like among sailors and showed which inclusion and diversity (I&D) competencies, when demonstrated correctly, are most impactful for building an inclusive environment. Our research also shows which command practices and policies contribute to greater acceptance for inclusion. Based on our results, our research shows that underrepresented racial/ethnic groups and females feel less included overall. We then validated that East Coast sailors feel less included compared to

West Coast sailors. Based on our findings, we recommend more general military training and utilizing pilot programs to improve emotional intelligence throughout the military. We also recommend distributing the survey throughout the Navy to gain a more complete understanding of diversity and inclusion in the fleet. We believe these findings will improve Navy leadership and help minimize exclusion based on racial, gender, and minority status, thus enhancing our military's strength.

Keywords: inclusion, diversity, underrepresented groups, minorities, sea-duty, shore-duty, exclusion, Task Force One Navy, qualitative, quantitative, African American, women, female, male, logit regression, linear regression

MARINE CORPS OFFICER ACCESSION: AN ANALYSIS OF EFFECTS ON CAREER-LEVEL PROMOTION

David R. Conlan, Major, United States Marine Corps
Master of Science in Management
Advisor: Chad W. Seagren, Graduate School of Defense Management
Second Reader: Simona L. Tick, Graduate School of Defense Management

The purpose of this research was to determine the significance of Marine Corps officer accession sources in relation to achieving career-level promotion benchmarks. The study first determined what characteristics the Marine Corps values in selecting officers for promotion to major and lieutenant colonel. Then, the study compared the focus variables of accession source to determine if any specific program is more likely to produce career-level officers. Logit multivariate analysis models were applied to officer data from 2000 to 2010 to answer these questions. The results suggest that master's degrees, personal awards, physical fitness, marksmanship, and fitness report evaluations, particularly Reviewing Officer assessments, are statistically significant in determining promotion to major and lieutenant colonel. The findings also indicate that accession source has a negligible impact on promotion, with only marginal statistical evidence suggesting that United States Naval Academy graduates are more likely to remain in service and promote to major and lieutenant colonel when compared to graduates of other accession sources. Based on these results, this research concludes with policy recommendations and suggestions for future research topics related to officer performance and promotion.

Keywords: accession source, commissioning source, retention, promotion, major, lieutenant colonel

AN ANALYSIS OF PERSONALITY TRAITS AND LEADERSHIP PERFORMANCE AT THE UNITED STATES NAVAL ACADEMY

Michael Crawford, Lieutenant, United States Navy
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Co-Advisor: Jeremy A. Arkes, Graduate School of Defense Management

To maintain its maritime advantage, the Navy must select and develop effective leaders. Organizations widely use information on personality traits of employees to help identify and develop leaders. In this thesis, I investigate whether extroverts are more likely to become leaders, and whether extroverts make better leaders. I use data on U.S. Naval Academy midshipmen who complete the Myer Briggs Test Indicator (MBTI) for personality type awareness. In their senior year, midshipmen have opportunities to be selected for leadership positions in the Brigade. Using data on senior midshipmen who graduated from USNA between 2005 and 2010, I estimate multivariate models to analyze the impact of extroversion on (a) selection for a leadership position and (b) leadership performance. The results show some evidence that extroverts might have a higher probability of selection for key battalion leadership positions, but not at the company leader level or below. The estimates find no difference in leader performance between introverts and extroverts, as measured by peer and senior officer

evaluations. Some limitations of this analysis relate to the data: the MBTI might not be the best instrument for measuring extroversion, and the leader performance measures may be "noisy" indicators of true performance. Using the Big 5 personality test recently adopted by USNA, future research could add more insight into the impact of personality on leadership selection and performance.

Keywords: performance, leadership, extroversion

BOOTCAMP ACCESSION TRIMESTER EFFECTS ON PERFORMANCE AND RETENTION

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Co-Advisor: Jeremy A. Arkes, Graduate School of Defense Management

Each year the Marine Corps recruits more than 30,000 enlistees. In an effort to obtain high-quality enlistees, over 40 percent of enlistees ship to bootcamp during the June, July, August, and September trimester. In this thesis, I analyze the Marine Corps' accession plan and the relationship between a Marine's accession trimester and time awaiting training as well as their likelihood to re-enlist after their first term and the probability of attrition prior to completing their first term. Additionally, this study determines if enlistees from the June, July, August, and September trimester outperform enlistees from the other trimesters. I use linear regression models and graphical trend analysis to estimate the relationships. I find that June, July, August, and September enlistees have the highest mean days awaiting training. Furthermore, the phasing approach increases the time awaiting training days for the following trimester. The increase in time awaiting training appears to be negatively associated with the probability of re-enlistment. Graphical analysis suggests the June, July, August, and September enlistees did not perform better than their counterparts; however, the differences in performance measure are minor. The attrition model shows a modest negative correlation between time awaiting training and likelihood of attrition. Considering high-quality enlistees accumulate the most days, the estimated effect is logical.

Keywords: attrition, bootcamp, accession, performance, retention, recruiting, time awaiting training, Marines awaiting training

CYBERSECURITY COST EFFECTS ON THE UNITED STATES MARINE CORPS' BUYING POWER

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Co-Advisor: Simona L. Tick, Graduate School of Defense Management

This thesis conducted a systematic literature review to synthesize and analyze current research on cybersecurity investment risk that may inform the Marine Corps' future cybersecurity investment decisions. Using both public and private sector research on cybersecurity investment risk allowed for a broad look at academic studies that approached similar issues. This thesis makes recommendations on framework and two models that may be adopted by the Marine Corps as effective decision-making tools to help leadership. This research is important because the Marine Corps could benefit from an investment decision-making tool that is robust, works in a constrained budget environment, and allows for leaders to understand the risks of their decisions.

Keywords: cybersecurity investment, risk, discretionary spending, non-discretionary spending, military buying power

YOU RECRUIT WHO YOU ARE: THE QUALITY RELATIONSHIP BETWEEN MARINE RECRUITER AND ENLISTEE

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Second Reader: Jeremy A. Arkes, Graduate School of Defense Management

In recruiting, the phrase "you recruit who you are" describes a presumed relationship—recruiters attract and enlist individuals who are similar to themselves or within their in-group. This research evaluates the correlation of high-quality recruiters on high-quality enlistees. For the 264,681 recruiter-enlistee pairs from 2011 to 2019, quality is defined and determined for both recruiters and enlistees with five metrics using DOD enlistment standards and Marine Corps promotion and retention standards. I use linear probability models with RSS fixed effects and year fixed effects to hold constant market conditions and variations across years. Based on the five metrics, I find that high-quality recruiters have a consistently positive estimated effect on high-quality enlistees across all metrics with several effects statistically significant. I surmise that, by determining which Marines are high-quality prior to their assignment to recruiting, the Marine Corps may affect the quality of the enlistees at accession. Because force design necessitates higher-quality accessions, this thesis therefore recommends that the Marine Corps consider sending more high-quality Marines to recruiting duty to potentially improve the quality of the warfighting organization. Conversely, if the Marine Corps does not prioritize and send high-quality Marines to recruiting duty, then the Marine Corps may pay the price with lower quality enlistees.

Keywords: recruiting, Marine Corps, enlistee, recruiter, recruiting assignment, special duty assignment, SDA, HSST, MMEA-25, basic recruiter course, BRC, quality, Marine Corps recruiting command, MCRC, USMC, in-group theory, recruiting substation, RSS, DOD Enlistment Standards, JEPES, junior enlisted performance evaluation score

PARENTHOOD AND ITS EFFECTS ON THE HEALTH AND PERFORMANCE OF DUAL-MILITARY MARINES

This paper has been recognized as outstanding by its department.

Amanda Henegar, Captain, United States Marine Corps
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Co-Advisor: Yu-Chu Shen, Graduate School of Defense Management

Proper talent management is essential to the longevity of the Marine Corps, and it is vital that policies exist to support and retain current personnel. Parenthood is a common experience among Marines, and Marine families continue to contribute to the Marine Corps' overall mission accomplishment. The majority of research has evaluated how childbirth impacts traditional families, but little emphasis has been dedicated to Dual-military (Dual-mil) families. My research examines parenthood effects on Dual-mil Marines and identifies former Dual-mil Marines in the data. We believe Dual-mil Marines respond differently to parenthood. I conduct an event study analysis that uses personnel data from 2010–2019 to estimate the effects of birth on Dual-mil parents. Results show that childbirth impacts mothers' health and performance greater than that of fathers. Mothers in my study exhibited drops in all outcomes and notably never return to their pre-birth fitness levels. Male results illustrated that Dual-mil fathers exhibited greater drops in fitness following birth than other married fathers. Moreover, Dual-mil fathers exhibited a statistically significant drop in job performance immediately following birth, while other married fathers experienced a significant delayed performance drop. My research provides the Marine Corps with insight on Dual-mils and the effectiveness of current postpartum and parental leave policies.

Keywords: parenthood, retention, recruitment, Dual-mil, Dual-military, parental leave policy, pregnancy

PARENTHOOD AND ITS EFFECTS ON PERFORMANCE IN ACTIVE DUTY MEDICAL PERSONNEL

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Master of Science in Management

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Co-Advisor: Latika Hartmann, Graduate School of Defense Management

Minimal research to date has examined the impact of new parenthood on either military personnel or medical professionals. This thesis aims to identify the specific impacts of new parenthood on performance of military medical professionals, a group of highly skilled, in-demand, and costly-to-train servicemembers. Using quarterly data from 2013-2019 obtained from the Army Person Data Environment, we used individual fixed effects models to identify how new parenthood impacts physical performance of Army and Navy medical enlisted and officers, using physical fitness test scores and body mass index. Models were controlled for age and analyzed by gender and officer/enlisted status. Results indicate that parenthood has significant negative effects on new parent physical fitness for military medical personnel. Detrimental effects to fitness persisted longest for female officers. Negative effects were greater in female personnel than male personnel and greatest in female officers. These results indicate a need to adopt policies that promote a culture of fitness that coincides with parenthood, including, but not limited to, universal adoption of physical training during work hours, resources directed toward physical training in the pregnancy and postpartum periods, safe physical training while under other life stressors, such as sleep deprivation, and general lifestyle health behaviors. Modifying the timeline of postpartum return to physical fitness testing may also be warranted.

Keywords: parenthood, performance, military, medical, readiness

ARE MENTORS BENEFICIAL? MENTORS' PERFORMANCE AND ATTRIBUTES AS PREDICTORS OF RETENTION FOR MARINE OFFICERS COMMISSIONED FROM NROTC PROGRAMS

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Master of Science in Management

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Co-Advisor: Sae Young Ahn, Graduate School of Defense Management

The Marine Corps' current manpower system focuses on producing quantity over quality and fails to encourage those it wants and needs to keep to increase the diversity and longevity of its officer corps. A renewed emphasis has been placed on understanding what factors may affect an officer's decision to remain serving. Literature suggests that a mentoring relationship may have a positive effect on retention. In this study, we first explore the predictive power of socio-demographic variables on retention, updating findings from previous studies. Multivariate analysis findings confirm the previous findings that married officers with dependent children are more likely to choose to retain throughout measured retention milestones. Furthermore, the U.S. Naval Academy (USNA) continues to show the highest retention rates among other commissioning sources. We then focus on the officers commissioned from a Naval Reserve Officer Training Corps (NROTC) program to examine how a mentor's (Marine Officer Instructor) performance and shared attributes with a mentee (midshipman) predict retention behavior for the mentee at the 5- and 7-year milestones. Our findings do not definitively indicate that a mentor's performance or having shared attributes with a mentee are significant predictive factors for a mentee's retention decisions, suggesting that additional work on the mentor-mentee relationship and its effect on retention is warranted.

Keywords: retention, mentorship, NROTC, Naval Reserve Officer Training Corps, MOI, Marine Officer Instructor

HOW THE U.S. NAVY CAN BECOME A BETTER LEARNING ORGANIZATION

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Co-Advisor: Nicholas Dew, Graduate School of Defense Management

How can the Navy become a better learning organization? This thesis addresses this question by taking a precise look at what a learning organization is, what its essential parts are, and why they are important. This research is qualitative in nature and includes analyses of published literature, public records, congressional testimonies, committee hearings, and documented reform attempts. The work attempts to answer why the Navy has struggled to become a learning organization in the past, where it has found some small successes, and what the reasons are for failure. In summary, smarter organizations are more adaptable to challenging scenarios and change, and both individual sailors and teams are more likely to innovate and find solutions in changing environments when a strong learning infrastructure is in place. A learning organization provides a supportive structure that enables and encourages learning and brings with it a culture of collaboration and innovation by removing some of the barriers that prevent individual learning processes from succeeding by themselves. The Navy's ability to learn as an organization is important because a Navy that has the capability to learn quickly and efficiently has a long-run advantage over its rivals.

Keywords: learning organization, organizational learning, learning, innovation, collaboration

APPLYING PREDICTIVE ANALYTICS IN ASSESSING HEALTH CONDITIONS OF APPLICANTS

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Advisor: Yu-Chu Shen, Graduate School of Defense Management
Co-Advisor: Latika Hartmann, Graduate School of Defense Management

Predicting military attrition due to conditions that existed prior to service is a complicated problem. My thesis explores underwriting practices and risk assessment in the life and health insurance industries with the aim to link private sector underwriting techniques to the military medical screening process. I review the current prediction models in the economic, actuary, and medical fields and find many of these models utilize complicated machine-learning algorithms to include random forests, deep convolutional neural networks, and deep dynamic memory neural network models. For my empirical analysis, I utilize a Cox proportional hazard model to determine risk via potential predictor variables. My findings suggest past self-inflicted injuries, substance use disorder (current and in the past), waivers for drug offenses, missing an Armed Forces Qualification Test (AFQT) score, and deployments (current and in the past) are associated with higher hazard rates of separation. This information provides insights regarding the separation risks associated with various indicators.

Keywords: logistic, predictions, attrition, medical, pre-existing conditions, MEPS, Military Entrance Processing Stations, AFQT, Armed Forces Qualification Test

IMPROVING USMC RETENTION QUALITY THROUGH REENLISTMENT PRE-APPROVAL

This paper has been recognized as outstanding by its department.

Nicholas Norville, Captain, United States Marine Corps
Master of Science in Management
Co-Advisor: Chad W. Seagren, Graduate School of Defense Management
Co-Advisor: Marigee Bacolod, Graduate School of Defense Management

Improving the quality of Marines retained has long been an objective of the Marine Corps' mission. This study assesses the effectiveness of utilizing a recently proposed binary logistic regression to select the most qualified Marines, based on their performance data, for pre-approved retention. Currently, all Marines desiring retention must submit a Reenlistment, Extension, and Lateral Move (RELM) request and await the Marine Corps' approval or rejection decision. Implementing a targeted reenlistment pre-approval process could improve the quality of retention in the Marine Corps. To target the highest quality Marines, this study looks at the quality of Marines selected for pre-approved retention in relation to the overall First-term Alignment Plan (FTAP) retention goal and examines the effectiveness of pre-approval selection at identifying improved subsequent term performance for those Marines who have already been retained. This study also analyzes the potential impact of pre-approved retention on the availability of boat-spaces and the number of reenlistment requests submitted. The results suggest that by targeting the highest quality (Tier-I) Marines, improved quality retention can be obtained without exceeding FTAP retention goals. Additionally, the results indicate the proposed pre-approval model effectively predicts quality performance in a Marine's subsequent term as indicated by tier calculation performance variables.

Keywords: talent management; reenlistment; pre-approval; USMC; retention; First-term Alignment Plan, FTAP; Reenlistment, Extension, and Lateral Move; RELM

A LOCATION-BASED INSPECTION OF DIVERSITY IN MARINE CORPS OFFICER ACCESSIONS

Brent M. Ogden, Captain, United States Marine Corps
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Advisor: Daniel Reich, Graduate School of Defense Management
Co-Advisor: Marigee Bacolod, Graduate School of Defense Management

With the policy goal of gaining access to a higher quality and quantity of diverse Marine officer candidates, this thesis examines the spatial distribution of Officer Selection Offices relative to the Qualified Candidate Population (QCP) through the census by the Center for Naval Analyses (CNA). For context, the structure of U.S. Marine Corps Recruiting Command (MCRC) and the officer selection process are examined before exploring the types and methodology of the QCP process, including the delineation between school and county-level QCPs and the metrics that are considered in their formulations. A literature review examines minority thoughts on service in the Marine Corps and looks at an overview of demographics throughout the officer ranks of the service. The impact of diversity on professional organizations is considered. Set cover optimization models are discussed and proposed as an optimization modeling framework for follow on studies. Using an application program interface and computer programming, latitude and longitude data is retrieved and associated for all candidate and Officer Selection Station (OSS) locations. Visualization is then applied to inspect the adequacy of OSS coverage for the top geographic locations and universities identified by the CNA. Finally, a summary of findings is provided.

Keywords: diversity, female, Marine Corps, officer, recruiting, Qualified Candidate Population, QCP, Center for Naval Analyses, CNA, U.S. Marine Corps Recruiting Command, MCRC, Officer Selection Station, OSS

EFFECTS OF HOMESCHOOL EDUCATION ON ENLISTED MARINE QUALITY

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Advisor: Sae Young Ahn, Graduate School of Defense Management
Co-Advisor: Marigee Bacolod, Graduate School of Defense Management

Survey and polling data suggest that the U.S. homeschooled student population is increasing. Annual Marine Corps enlistments of homeschool graduates are also rising after a provision contained in the 2014 National Defense Authorization Act granted homeschoolers the same enlistment status as high school graduates. The purpose of this study is to determine how these trends impact Marine Corps recruiting efforts and whether homeschooled students differ significantly from the Marine Corps' primary recruiting market, traditional high school graduates. Statistical variations between homeschool and high school graduates are analyzed by examining yearly observations of enlisted accessions from fiscal year 2011 through fiscal year 2020. Regression analysis is used to test for a distinguishable difference between Marines whose highest education credential is either a homeschool or high school diploma. Performance and quality are measured across mental, physical, and behavioral categories selected to represent the "whole Marine concept." Results ultimately reveal no statistically observable difference exists between Marines who graduated from a traditional four-year high school and those who enlisted with a homeschool diploma.

Keywords: attrition, recruiting, homeschool, TAPAS, Tailored Adaptive Personality Assessment System

ANALYZING OUTCOMES AND PUNISHMENTS AWARDED AT COURTS MARTIAL IN THE USMC FOR SYSTEMIC DIFFERENCES

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Master of Science in Management
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Co-Advisor: Chad W. Seagren, Graduate School of Defense Management

Results of all special and general courts-martial in the Marine Corps from January 2017 to August 2020 were analyzed for systemic differences in terms of trial outcomes and punishments. Trial outcomes were obtained from the Marine Corps' legal database and combined with demographic and service data obtained from the Total Force Data Warehouse. Multiple regression analysis was performed with trial outcomes and various categories of punishments awarded utilized as outcome variables. Racial/ethnic, demographic, and service information were utilized as explanatory and control variables. The race/ethnicity of trial personnel, to include trial counsel, defense counsel, and military judge, were also analyzed to determine whether they impacted the outcome of the trial, or whether there were any effects on the interaction between the race/ethnicity of the accused and trial personnel. Outcomes were also analyzed within certain categories of misconduct, specifically trials where Marines were charged with misconduct concerning drug use, sexual misconduct, and the general article. The population representation of the Marine Corps was compared to the demographic makeup of the court-martial sample populations to identify instances of over- and under-representation. Significant over-representation of Black Marines and under-representation of White Marines was found in the courts-martial population. Trial outcomes and punishments were generally not influenced by any racial/ethnic factors.

Keywords: courts-martial, legal, systemic, regression, race, ethnicity, UCMJ, equity, bias

ANALYSIS OF SMOKING BEHAVIORS IN AFLOAT COMMANDS

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Co-Advisor: Jesse Cunha, Graduate School of Defense Management

The U.S. Navy offers a unique opportunity to explore the social role of smoking in the military, as it is used as a stress-relief tool in a high-pressure work environment. Navy ships are socially isolated, and smoking breaks serve as one of the few reprieves away from daily work. Through these observations, the aim of this research is to answer these questions: 1) Are there any peer effects affecting the propensity to smoke among specific job types in the Navy? 2) Are there variations in smoking rates across the different ship types? I compiled a de-identified individual-level database tracking active-duty sailors and their smoking-related diagnoses from 2002 to 2011. One key finding is that sailors on larger ships, such as carriers, have lower rates of being diagnosed with smoking disorders. In addition, I found peer effects in most rating groups, whereby sailors joining a command where many of their peers were recently diagnosed with a smoking-related illness have a higher likelihood of contracting a smoking-related illness in the future. The results of my research can advise future policies to reduce smoking rates among sailors by leveraging the nuanced cultural aspect of smoking in the Navy.

Keywords: destructive behaviors, smoking, tobacco, afloat commands, Navy

PREDICTORS OF SUCCESS AT INFANTRY TRAINING BATTALION USING COUNTERMOVEMENT JUMP METRICS

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Advisor: Marigee Bacolod, Graduate School of Defense Management
Co-Advisor: Jennifer A. Heissel, Graduate School of Defense Management

The enlisted infantry community, all of whom acquire their training at Infantry Training Battalion (ITB), comprises approximately 15% of the Marine Corps. It is therefore concerning when, on average, 12.9% of the Marines who attend ITB fail to graduate. The majority are dropped from ITB training for four reasons: MOS Specific Physical Standards (MSPS) assessment failures, academic failure, medical injuries, and administrative issues. Of the four reasons, MSPS accounts for the majority of the failures (35.7%), followed by Academics (34.39%), Medical (23.35%), and the remainder (6.47%) for Administrative. These statistics warrant investigation to determine what metrics can be utilized to mitigate failures. In 2019, ITB introduced a new curriculum that includes a newly developed MOS Specific Physical Standards assessment and force platforms to measure human kinetics and biomechanics through a Countermovement Jump (CMJ) test. Data from multiple sources applied to econometric and machine learning models revealed that cognitive ability, demographics, physical performance, and CMJ performance are significant predictors of success at ITB. The most significant predictor turns out to be an interaction of cognitive ability and CMJ, indicating the complementarity of "brain and brawn" in determining success at ITB. Continued CMJ data collection and analysis could provide valuable insights into prediction-based schoolhouse training models.

Keywords: Infantry Training Battalion, ITB, Marine Corps, Countermovement Jump, CMJ, Force Platforms, MOS Specific Physical Standards, MSPS

IMPACT OF HIGH SCHOOL QUALITY ON THE CONDUCT AND ATTRITION OF ENLISTED MARINES

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This study investigates the impact of high school quality and peer group characteristics on the misconduct and attrition of enlisted Marines. Multivariate regression models employ personnel data from the USMC Total Force Data Warehouse on 22,177 enlisted Marines who joined the USMC during fiscal year 2013 and high school identifiers from the Common Core of Data. Misconduct incidents per year of service, propensity to commit misconduct, propensity to attrite within six years, and propensity to attrite under undesirable circumstances are regressed on high school quality, the number of fellow Marines from the same high school, and demographic breakdown of those fellow Marines. The model results show that high school quality, in itself, does not impact misconduct or attrition. Attending a high-quality high school does, however, amplify the negative impact that a higher Armed Forces Qualification Test (AFQT) score has on propensity to attrite within six years. High school enlistment peer group size does not significantly impact misconduct or attrition. The percentage of high school enlistment peer group that consists of female, black, or Hispanic Marines does not impact the misconduct or attrition outcomes for those groups. We recommend that the USMC not invest time or resources toward recruiting Marines specifically from high-quality high schools, recruiting larger peer groups from each school, or achieving a specific demographic breakdown of recruits from each school.

Keywords: education, proficiency, misconduct, manpower, enlisted, Marine

MARINE CORPS CHILDCARE DEVELOPMENT CENTER (CDC) WAITLIST TRENDS AND IMPACT ON FAMILIES

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Co-Advisor: Paul Lester, Graduate School of Defense Management

Across the fleet, Marine Corps installations provide childcare services to support military members and their families. These on-base services include those provided by the Childcare Development Center (CDC), which serves infants and children through age five. While the main goal of the CDC is to provide high quality and easily accessible childcare to military families, many locations have developed excessive waitlists. This thesis compares the CDC capacity data to the population, by age group, from January 2010 to March 2020 at Marine Corps installations across the fleet. A detailed comparison across the bases is made to identify trends that potentially have an impact on childcare waitlists. This thesis also examines the waitlist data for each installation from March 2018 to March 2020 to analyze seasonal enrollment fluctuations. Data from thirteen Marine Corps Bases, including those in Japan and Hawaii, is analyzed.

Keywords: Childcare Development Center, CDC, waitlists, infants, military families, Marine Corps families

EXPLANATORY FACTORS THAT CONTRIBUTE TO MV-22 READINESS

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Second Reader: Eddine Dahel, Graduate School of Defense Management

The MV-22 Osprey is a critical component of national defense as it provides the Marine Air-Ground Task Force (MAGTF) with long-range, assault support capabilities to transport combat troops and equipment from ships and land bases to the battlefield. The MV-22 fleet has yet to maintain its readiness expectations; given the number of variables that contribute to squadron readiness, it is difficult to determine what resources to reallocate to guarantee consistent performance. This study examined the multiple variables that contribute to squadron performance and determined which are accurate predictors of readiness. Descriptive statistics and linear regression were used utilizing panel data from every Marine active-duty, deploying MV-22 squadron from fiscal years 2013 to 2020 to examine the relationship between multiple maintenance and operations factors and readiness. The graphical analysis highlighted the correlation between multiple explanatory variables and squadron MC% as well as consistent timeframes where most squadrons experience a decrease in readiness with different factors affecting their recovery. The results of the multivariate regression models showed the relationship between numerous Integrated Product Support (IPS) elements and squadron MC% whereas a sensitivity analysis conducted using Monte Carlo simulation showed that significant improvements in aircraft design and manpower allocation will increase the probability of achieving the CNO's MV-22 readiness goal.

Keywords: MV-22, Osprey, aviation, readiness, squadron, maintenance, Integrated Product Support, IPS, Marine Air-Ground Task Force, MAGTF, Chief of Naval Operations, CNO

INCREASING THE SERVICEMEMBERS' GROUP LIFE INSURANCE (SGLI) MAXIMUM PAYOUT

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This research addresses the decreasing worth of the Servicemembers' Group Life Insurance (SGLI) payout based on the year a servicemember dies. The SGLI maximum has stagnated at $400,000 for over 16 years and nearly every other servicemember entitlement or benefit has increased in this timeframe. Using four principal steps, this research first determines what the SGLI maximum should be using ordinary least squares (OLS) regression and compounding inflation rates. Second, it conducts trend analysis to determine statistically significant predictors of servicemember death trends and forecasts servicemember deaths, end strengths, and inflation rates for ex post analysis. Third, it determines the feasibility of the proposed increases using historical payout-to-contribution ratios to determine sustainable contribution rates for monthly premiums. Fourth, it discusses alternatives to still provide benefit to servicemembers and beneficiaries, regardless of policy change. The ultimate recommendation is to increase the SGLI maximum to $525,000 in 2021, then continue to increase at 5-year intervals to correct for inflation, ultimately increasing to $605,000 in 2041 at which point it can be reassessed or have the interval increases continue. With a 95 percent confidence interval, the models predicted between 757 and 2,596 annual servicemember deaths; total service end strengths between 798,529 and 2,300,810; and inflation rates between 0.44 and 5.56 percent until 2041.

Keywords: servicemembers group life insurance, SGLI, ordinary least squares, OLS

AN EXPLORATORY ANALYSIS OF INTERMEDIATE MAINTENANCE ACTIVITY BEYOND CAPABILITY OF MAINTENANCE TRANSACTIONS: DO END OF FISCAL YEAR BEHAVIORS IMPACT COST?

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Co-Advisor: Kenneth H. Doerr, Graduate School of Defense Management

There is a widely accepted notion that fiscal spending increases at the end of the fiscal year across different government levels. This phenomenon, particularly across the military services, is driven by the notion that follow-on-year authorizations will be decremented because these funds were not obligated to a 99.8% level of execution. There is anecdotal evidence of increased spend rates in the fourth quarter of the fiscal year. This study analyzes cost-driving trends across intermediate maintenance activities in support of Marine Corps aircraft squadrons to identify the year-end spend behavior. This study identifies end-of-year spending trends within a Marine Aviation Logistics Squadron (MALS). It proceeds with an exploratory analysis of the impact of spending patterns at the end of the fiscal year. The researcher focuses on beyond capability of maintenance (BCM) trends on the CH-53E aircraft to determine how end-of-year spending, maintenance practices, operational drivers, and financial constraints may impact stock position at the MALS. The researcher proceeds to examine the impact of priority levels on end-of-year spending. Additionally, data analyzed in this research cover a period of five years to identify trends as they pertain to the time elapsed while components await parts and the maintenance actions before the parts are processed as BCM.

Keywords: beyond capable maintenance, beyond capability of maintenance, BCM, cost drivers, aviation depot level repairables, AVDLR, fiscal-year closeouts, fourth-quarter spending, fiscal spending, top degraders, Marine Aviation Logistics Squadron, MALS

EFFECTS OF PREFERRED DUTY STATION ASSIGNMENT ON THE PERFORMANCE AND RETENTION OF USMC PERSONNEL

This paper has been recognized as outstanding by its department.

Ansley White, Captain, United States Marine Corps
Master of Science in Management
Advisor: Jennifer A. Heissel, Graduate School of Defense Management
Co-Advisor: Marigee Bacolod, Graduate School of Defense Management

In 2019, the Commandant of the Marine Corps stated in his planning guidance that "we should use money like a focused weapon, and aim it at the exact individual we need." In response to this call for targeted talent management reform, I use FITREP duty station preference and performance data to conduct fixed effects difference-in-differences and survival analysis to examine how assignment to a desired duty station affects the future performance and retention of Marines. Results indicate that enlisted Marines who are assigned to desired duty stations early in their careers on average perform .232 points higher on their FITREPs relative to Marines who are not. Top-tier performers who receive desired orders perform .336 better than their counterparts, and Marines who request and are assigned to the operating forces outperformed peers by 0.537. Assignment to desired duty stations is also highly correlated with the retention of top-performing officers. These are the Marines we need and want fighting our nation's wars, both on the ground and at the strategic level, and results indicate that preferential duty station assignment has a particularly positive impact on them. In his guidance, the Commandant also states that "an incentives-based model would offer the ability to target incentives to specific individuals the Service wants to retain." The results of this research indicate that preferential duty station assignment has the potential to do just that.

Keywords: talent management, retention, USMC, Marine Corps, Marine, duty station, duty assignment, personnel, performance, assignment, career, incentives, non-monetary incentive, duty station, preferences, FITREP, fitness report, years of service, preference-matching, Marine Command Code, MCC

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MASTER OF SCIENCE IN MECHANICAL ENGINEERING

SUBSTRATE AND FEEDSTOCK FACTORS AFFECTING COLD SPRAY COATING ADHESION AND RELATED IMPACTS ON CORROSION

This paper has been recognized as outstanding by its department.

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Master of Science in Mechanical Engineering
Advisor: Andy Nieto, Department of Mechanical and Aerospace Engineering
Second Reader: Troy Ansell, Department of Mechanical and Aerospace Engineering

Cold spray technology has the potential to greatly reduce the effects of corrosion on susceptible materials. Lack of adhesion strength is one of the limitations currently preventing cold spray from becoming a dominant resource. Adhesion strength is the strength of the bond between the cold-sprayed coating and the substrate. Without good adhesion, the coating provides minimal protection against corrosion and could potentially make corrosion worse. In order to determine how to increase cold spray adhesion, the feedstock powder and substrate were manipulated to analyze their effects on adhesion. The main areas of focus for this project were the effects of the following characteristics on adhesion strength: i) the surface condition of the substrate, ii) the hardness of the substrate, and iii) the size of the cold spray particles. Samples within each area of focus were sprayed using cold spray and then a pull-off adhesion test was performed. The surface condition of the substrate was further studied to determine its effect on Mg AZ31 alloy's corrosion rate by placing a smooth, roughened, and polished sample within a salt fog chamber for 672 hrs. The results from the adhesion tests showed that softer substrates and smoother surface condition produce higher adhesive strength. The corrosion experiments found that the samples with the higher roughness value saw the highest corrosion rates and formed the thickest oxide layer.

Keywords: cold spray, adhesion strength, surface treatment, particle distribution, packing, aluminum, magnesium

GAS TURBINE CONVERSION FROM LIQUID TO GASEOUS FUEL

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Co-Advisor: Walter Smith, Department of Mechanical and Aerospace Engineering

The DOD consumes more energy than any other federal agency to power its many installations and operational assets, prompting the need for robust energy management and solutions. With emerging technologies and a growing reliance on electrical systems, the DOD and DON recognize that energy production, procurement, and usage must be further optimized and secured. This study aims to support research toward a portable and affordable electric generation system capable of supplying power to microgrids. Specifically, it investigates the feasibility of converting liquid-fueled combustion engines to operate with renewable gaseous fuels, namely hydrogen gas. To test this hypothesis, performance measurements and internal inspection were conducted on the JetCat P60-SE turbojet, a small commercial gas turbine engine designed for remote-controlled hobby jets. The results showed that with effective modifications, a liquid-fueled gas turbine has the potential to operate with gaseous fuels. These findings can be used toward larger applications, expanding the application of hydrogen technology to electrical generation.

Keywords: gas turbine, turbojet, JetCat, kerosene, propane

WASTE HEAT RECOVERY ANALYSIS OF A GAS TURBINE HEAT EXCHANGER

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Second Reader: Douglas L. Seivwright, Department of Mechanical and Aerospace Engineering

The U.S. Department of Defense has employed an initiative to become more conservative and efficient regarding uses of energy across all military services. The Naval Postgraduate School supported development toward this initiative by studying the possibility of electrical power generation using waste heat recovery within shipboard engine exhaust. This research included the development of a heat exchanger to use compressed carbon dioxide gas as the working fluid to run within a Brayton cycle. This thesis is built upon previous research using a Rolls Royce M250 helicopter engine and previously modified heat exchangers that were installed on the engine's dual exhaust. The effects that the modified heat exchangers had on the engine were measured and analyzed to determine new baseline efficiency and effectiveness parameters for the engine and heat exchanger, respectively. Nitrogen and carbon dioxide were used to develop baseline results. Additionally, an independent study was performed on the performance of an Organic Rankine Cycle waste heat recovery system at Cal Maritime Academy onboard its training ship, and results were presented and discussed.

Keywords: waste heat recovery, heat exchanger, carbon dioxide, gas turbine

MASTER OF SCIENCE IN METEOROLOGY & PHYSICAL OCEANOGRAPHY

APPLICATIONS OF BAYESIAN NEURAL NETWORKS TO GLOBAL PRECIPITATION MEASUREMENT MISSION DATA

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Master of Science in Meteorology
Advisor: Scott Powell, Department of Meteorology
Co-Advisor: Marko Orescanin, Department of Computer Science

Meteorological remote sensing efforts have advanced operational decision making and scientific research over the last half-century by providing high-quality global observations of the land, atmosphere, and ocean. The continued development of convolutional neural networks (CNNs) and Bayesian neural networks shows potential for allowing some of these datasets to be synthetically produced where they cannot be directly observed. In this thesis, global precipitation measurement mission (GPM) data is used to train a rain-type classification Bayesian CNN (BCNN) using passive microwave data. Additionally, regression CNNs and BCNNs are trained to predict precipitation using GOES-16 multispectral infrared data over a tropical maritime region. The rain-type classification BCNN shows a 17% improvement in accuracy over existing literature, and the regression models demonstrate a proof of concept in using GPM radar data and geostationary radiances to train skillful CNNs and BCNNs to predict radar reflectivity and rain rate. The experiments demonstrate both the promise of using these data sources to train accurate models and the possible advantages of using BCNNs to quantify and better understand prediction uncertainty for these applications.

Keywords: artificial intelligence, remote sensing, tropical meteorology, convolutional neural networks, CNN, passive microwave, geostationary, synthetic radar, global precipitation measurement mission, GPM, Bayesian convolutional neural networks, BCNN, rain-type classification, GOES-16

USING BAYESIAN STATISTICAL POSTPROCESSING METHODS TO IMPROVE LOCAL WIND FORECASTS

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Second Reader: Joel W. Feldmeier, Department of Meteorology

This thesis explores the use of Bayesian statistical postprocessing to rapidly train a highly accurate forecast from a 1 km resolution gridded Weather Research and Forecasting (WRF) model forecast over a 100 km by 100 km area. These methods leverage three modeled forecast variables—10 m winds, sea-level pressure, and terrain elevation—in conjunction with downstream observations and prior model runs to identify model inaccuracies. Using only three days of data, a Bayesian corrected forecast is produced and analyzed for accuracy and improvement over the original model run relative to real-world observations. Over 90% of the resulting forecasts saw improvement over the raw model forecasts in root mean squared error, and over 87% of the forecasts saw improvement in mean error over the raw model forecasts. Extreme circumstances saw improvements in accuracy of over 9 knots while overall improvements were reliably seen both in accuracy and precision among Bayesian corrected forecasts. These findings are significant as they suggest that Bayesian

statistical postprocessing methods work and should be both employable at rapid rates, and result in more accurate forecasts.

Keywords: wind, forecast, Bayesian, Weather Research and Forecasting, WRF, model, accuracy, precision, small-scale, local

FORMATION AND DESTRUCTION OF ARCTIC THERMOHALINE STAIRCASES

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Second Reader: Justin M. Brown, Department of Oceanography

This study explores the dynamics of diffusive convection, which is realized in regions where cool and fresh water-masses rest on top of those that are warm and salty. This type of convection is often observed in the Arctic Ocean and is characterized by the development of fine-scale steps in vertical salinity and temperature profiles known as thermohaline staircases. The Arctic staircases control the rate of upward heat transfer from waters of Atlantic origin, thereby influencing the melting of sea-ice and the polar climate in general. This thesis aims to utilize numerical modeling to define conditions that are favorable or unfavorable for creating thermohaline staircases and provide an explanation as to why they are not constantly prevalent throughout the Arctic. In particular, the presented high-resolution simulations explore the role of vertical shear associated with internal waves that are ubiquitous in the World Ocean. While previous investigations suggested that the vertical shear could adversely affect staircases, this effect has not been quantified and physical mechanisms at play are still poorly understood. The present study addresses these unresolved problems in the theory of double-diffusive convection, concurrently shedding light on the mechanics of heat transfer in high-latitude oceans.

Keywords: Thermohaline staircase, shear, double diffusion, Arctic Ocean, vertical shear, heat transfer, internal waves, convection

MASTER OF SCIENCE IN NETWORK OPERATIONS AND TECHNOLOGY

USING MACHINE LEARNING TO PREDICT THE INSIDER THREAT IN A NETWORK ENVIRONMENT

Natasha K. Niemann, Lieutenant, United States Navy
Raymond G. Blockmon, Major, United States Army

Master of Science in Network Operations and Technology

Advisor: Vinnie Monaco, Department of Computer Science
Co-Advisor: Brian P. Wood, Department of Information Sciences
Second Reader: Charles Timm, TRAC, NETCOM

In the past, cybersecurity professionals relied upon Security Event and Information Management systems to ingest network, server, and host logs to assist in detecting suspicious and malicious activity in the network. Detecting threat activities also included manually inspecting packet captures to glean clues of nefarious activity. Our research involves machine learning. We developed a model that observes the packet headers' characteristics when a user accessed a remote file server. Data sets were introduced and host-server configurations were used to determine if our classification model was consistent in identifying file access behavior. We were able to predict and classify file access behavior, such as uploading, downloading, deleting, and moving files on a file server, based upon using headers. The results from deriving the classifications were similar when using different host-server configurations and files. Our research demonstrated potential avenues to study file access behavior on an enterprise network. Information repositories like file servers, SharePoint, and online data hosting sites such as Dropbox present a surface threat for information theft. Classifying file access behavior with these online resources presents a valuable goal for cybersecurity.

Keywords: machine learning, networks, security, network operation centers, cyber center, cyber, security threat, computer network

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MASTER OF SCIENCE IN OPERATIONS RESEARCH

ANALYZING US NAVY F/A-18 FUEL CONSUMPTION FOR PURPOSES OF ENERGY CONSERVATION

This paper has been recognized as outstanding by its department.

David Barnhill, Commander, United States Navy
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Second Reader: Lyn R. Whitaker, Department of Operations Research

Energy usage and conservation are perennial challenges facing the Naval Aviation Enterprise (NAE) and the U.S. Navy (USN) writ large. In order to promote USN energy conservation, the Naval Air Systems Command (NAVAIR) established the Air Energy Conservation (Air ENCON) program to further analytics-driven energy consumption assessment and assist the USN to meet broader conservation goals. This study used a flight sortie data set built by Deloitte Consulting, constructed from three separate data sources, to assess F/A-18 fuel consumption, aiding Air ENCON analysis goals. The data set, which was derived from aircraft memory unit (MU) recordings, Naval Aviation Flight Records (NAVFLIR), and the Sierra-Hotel Aviation Readiness Program (SHARP) records, consisted of more than 466,000 USN F/A-18 sorties spanning a four-year time frame. This research evaluated the veracity of sortie data fuel output metrics and identified broad fuel consumption trends despite a significant proportion of missing or unused information. Furthermore, this thesis documents the effectiveness of the data to predict fuel consumption by use of original and generated predictors in combination with various imputation methods. Results suggest that while statistical inference is difficult due to the amount of missing data, broad trends related to sortie location are identifiable, and models using imputation coupled with original and generated predictors exhibit the best results for predictive effectiveness.

Keywords: fuel, fuel conservation, F/A-18, E-2D, E/A-18, naval aviation, machine learning, predict

STUDENT ACHIEVEMENT INDICATORS AT DEFENSE LANGUAGE INSTITUTE FOREIGN LANGUAGE CENTER

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Co-Advisor: Jonathan K. Alt, Department of Operations Research
Second Reader: Colby J. Smithmeyer, US Army TRADOC Analysis Center

The Defense Language Institute (DLI) trains most of the cryptologic language analysts (CLA) that perform translation and analysis of data to support the United States military and intelligence communities. Students take the Defense Language Proficiency Test (DLPT) when graduating, passing if they achieve a score of L2/R2 (2 on the Listening portion, 2 on the Reading). DLI has been ordered to improve its students' scores upon graduation. It seeks an improved model to screen applicants for the potential to achieve the new, more difficult grading benchmark of 2+ Listening, 2+ Reading. Former NPS student Jonathan Bermudez-Mendez looked into predicting student test scores based on grades, prior language experience, Defense Language Aptitude Battery (DLAB) scores, whether a student was recycled from a different language program, language category, and whether the student attended an immersion program, using stepwise logistic regression. We show that random

forests and neural networks, especially the former, can improve on existing predictive models. We also investigate some univariate relationships based on prior language experience and show that many aspects of prior language exposure are statistically significantly related to the event of a student passing at the new benchmark.

Keywords: DLI, Defense Language Institute, Defense Language Proficiency Test, DLPT, language, success, grades, Defense Language Aptitude Battery, DLAB, stepwise, logistic, regression, random forest, neural network, step-wise, model, categorical, numeric, data, ASVAB, Armed Services Vocational Aptitude Battery, classification table, goodness of fit, sensitivity, specificity, Receiver Operating Characteristic, ROC, Area Under the Curve, AUC

OVERCOMING FLAWS IN THE MISSION DEPENDENCY INDEX (MDI) WITH NETWORK FLOW ANALYSIS

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Master of Science in Operations Research
Advisor: Daniel Eisenberg, Department of Operations Research
Second Reader: David L. Alderson Jr., Department of Operations Research

The Mission Dependency Index (MDI) is a metric used by all U.S. military services for guiding operations, management, and funding decisions for facilities at military installations. Despite its broad adoption, several studies on MDI suggest it may have flaws that limit its efficacy. We present the first rigorous technical analysis of MDI as to how its flaws impact decisions and determine ways to overcome them. We develop a formal mathematical definition of MDI based on multilayer networks that supports reproducible models and formal analysis of the MDI calculation process used in the U.S. Navy. Based on our multilayer formalism, we define three technical problems with MDI methods not previously discussed in the literature. We develop a new model for calculating MDI based on network flow analysis that overcomes these problems. We demonstrate our new approach by assessing the vulnerability of a realistic diesel fuel marine mission to facility disruptions. Overall, our work provides clarity on how to interpret and avoid pitfalls in MDI calculation and use.

Keywords: Mission Dependency Index, MDI, infrastructure, network, multilayer

SOLVING REWARD-COLLECTING PROBLEMS WITH UAVS AGAINST THE STOCHASTIC ADVERSARY THROUGH REINFORCEMENT LEARNING AND ONLINE OPTIMIZATION

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Master of Science in Operations Research
Advisor: Ruriko Yoshida, Department of Operations Research
Second Reader: Michael P. Atkinson, Department of Operations Research

Unmanned autonomous vehicles (UAV) have made significant contributions to reconnaissance and surveillance missions in past U.S. military campaigns. As the prevalence of UAVs increases, there have also been improvements in counter-UAV technology that make it difficult for UAVs to successfully obtain valuable intelligence within an area of interest. Hence, it has become important that modern UAVs can accomplish their missions while maximizing their chances of survival. In this work, we specifically study the problem of identifying a short path from a designated start to a goal, while collecting all rewards and avoiding adversaries that move randomly on the grid. We present a comparison of two methods to solve this problem: a Deep Q-Learning model and an online optimization framework. Our computational experiments, designed using simple grid-world environments with random adversaries, showcase how these approaches work and compare them in terms of performance, accuracy, and computational time.

Keywords: reinforcement learning, agent-based environment, online optimization, reward-based game, UAV flight pattern, Deep Q-Learning

CHALLENGES OF USING INCONSISTENT HEAD POSES TO CLASSIFY DEEPFAKES

This paper has been recognized as outstanding by its department.

Kevin D. Lutz, Lieutenant, United States Navy
Master of Science in Operations Research
Advisor: Robert L. Bassett, Department of Operations Research
Second Reader: Ross J. Schuchard, Department of Operations Research

Political leaders, military leaders, and the general public gather information from images and video to make decisions. Media can be spread instantaneously throughout the world at low cost and anonymously using social media, allowing small groups to gain powerful influence. This leaves the United States vulnerable to deception by media forgery. The problem of media forgery is not new, but the recent advances in machine learning have led to the development of DeepFakes, which are more sophisticated and difficult to identify. DeepFakes are especially dangerous because they can be used to change the identity of a person in a video or image. Detecting DeepFakes has been the focus of academic research, and several techniques have been developed and show promising results on available data sets, but the suitability of these algorithms for deployment within the Department of Defense or any other critical environment is an open question. This research provides a decisive answer to this question for a promising recent analytic that uses inconsistent head poses to detect when an image is manipulated.

Keywords: DeepFake, deep learning, machine learning

DEVELOPING A FRAMEWORK FOR ANALYZING THE RESILIENCE OF FORWARD EXPEDITIONARY PORT REFUELING INFRASTRUCTURE

This paper has been recognized as outstanding by its department.

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Advisor: Daniel Eisenberg, Department of Operations Research
Co-Advisor: Devaushi I. Singham, Department of Operations Research
Second Reader: Jeffrey E. Kline, Department of Operations Research

The U.S. Navy (USN) relies on ports to enable operations and project power, but many of our ports remain vulnerable to attack and natural disaster. To manage future conflict, the USN must plan for port resilience and develop resilience-enabling technologies that support ship refueling operations. We develop a framework and model capable of studying refueling at ports before and after disruptions. Our framework adapts standard tools for discrete event simulation of ship arrival and refueling, and we demonstrate its use for a simple port. Our methods also enable the analysis of resilience technologies currently being developed by the USN. We study two USN technologies: one enables fast port recovery, and the other enables extended port operations but does not speed up recovery. We find both technologies capable of providing resilience to ports in their own unique ways. Based on our analysis, we provide recommendations for how the USN should deploy both technologies, which enables efficient acquisition and port resilience.

Keywords: U. S. Navy, USN, resilience, discrete event simulation, refueling, vulnerability, sustainability, robustness, adaptability

AR TECHNOLOGY: EFFICIENCY IMPROVEMENT TOOL FOR SHIPBOARD MAINTENANCE

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Maintenance is a constant throughout the lifetime of a ship and needs to be as efficient as possible for the U.S. Navy to maintain the readiness, capability, and capacity of its surface fleet. The inability to find a maintenance item on a ship by repair personnel during a maintenance period is unacceptable. The current process relies on the written description of a work order, which besides the ship compartment, offers little guidance regarding the precise physical location of the maintenance item. This ambiguity causes inefficiencies in the execution of the repair. Augmented Reality (AR) has strong evidence of positive influence on maintenance in the private sector and, now that it is more commonplace, the U.S. Navy should consider its first practical use. This research developed an experiment to compare the performance between the current process and AR-guided assistance, assessing the efficiency of subjects in terms of time, accuracy, and the subject's confidence in their ability to identify the proper item. The experimental environment involved two rooms differing in levels of complexity, representing shipboard compartments. Through statistical and exploratory analysis, the benefits of AR-guided assisted technology were demonstrated by its outperformance over the current process in all recorded measurements of the experiment. This research provides evidence that AR can potentially close the capability gap existing within the current process.

Keywords: augmented reality, shipboard maintenance, subject testing, maintenance availability, surface warfare

IMPROVING AUTOMATED SCHEDULES FOR NAVAL AIR STATION KINGSVILLE

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Currently, many squadrons in the Naval Aviation community handwrite their daily flight schedules, which is typically an all-day effort. This thesis creates an optimization model to build schedules computationally instead of manually for Navy's Training Squadron 22 (VT-22), which specializes in Intermediate Jet and Advanced Strike training. An optimized scheduling process can improve the efficiency of the training pipeline, saving money and improving aviation readiness. A preliminary model, Training Event Scheduling Tool (TEST), was provided to VT-22 in 2019 by Meditz. TEST takes a spreadsheet containing student prerequisites, instructors, and events, and creates a daily or weekly schedule at an hourly resolution. This thesis formulates and tests a revised integer linear program, TEST-2, an enhancement to TEST that models weather, substitutable events, and student currency. TEST-2 creates daily schedules in less than 10 minutes and weekly schedules in about four hours. These schedules consider a majority of the necessary constraints for a useable schedule. For a sample week's input provided by VT-22, TEST-2 schedules about 60 more events over the course of the week than were manually scheduled and completed. Currently, many events are cancelled due to instructor non-availabilities, weather, and jet availability. Because TEST-2 considers these three factors in building its schedules, cancellations due to these factors are minimized.

Keywords: optimization, naval aviation, scheduling, Training Event Scheduling Tool, TEST, Training Squadron 22, VT-22

MASTER OF SCIENCE IN SPACE SYSTEMS OPERATIONS

LAUNCH PARAMETERS OF AN ICE PAYLOAD TRAVELING VIA LUNAR ELECTROMAGNETIC LAUNCHER TO THE LUNAR GATEWAY

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This paper investigated one possible solution for procuring propellent needed for future space exploration missions. This study examined the feasibility of using an electromagnetic launcher (EML) to transport raw materials used in propellent production from the lunar south pole to NASA's Lunar Gateway. This proposed space station, located in a lunar near-rectilinear halo orbit (NRHO), is a critical part of NASA's Artemis program. Cheaply and efficiently sourcing lunar hydrogen from surface ice to the station would benefit the program's success and future exploration of the solar system. This research investigated the launch requirements for a lunar EML payload. AGI Inc.'s Systems Tool Kit (STK) was used to calculate the required launch azimuth, elevation, magnitude, epoch, and trip duration needed to intercept the Gateway. The model evaluated the payload and the Gateway's radial, cross-track, and in-track positions and rates to determine their relative positions and velocities at rendezvous. Conclusions from this research demonstrated that it is feasible to conduct a single launch from the lunar south pole and target any point along the Gateway's orbit with variable launch conditions. Evidence supporting our hypothesis is presented, showing it may not be possible to match the space station's state vector at rendezvous. The payload will require an additional thrust capability, suggestions for which were also explored in this paper.

Keywords: NASA, Artemis, Lunar Electromagnetic Launcher, lunar gateway, near-Rectilinear Halo Orbit Lunar South Pole, Systems Tool Kit, launch velocity, Earth-Moon orbital system, LaGrange Point, rendezvous

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MASTER OF SCIENCE IN SYSTEMS ENGINEERING

The following theses and capstone project reports were produced by residential and distance-learning students in the systems engineering curriculum. The degrees awarded include Master of Science in Systems Engineering, Master of Science in Engineering Systems, and Master of Science in Systems Engineering Management.

A SYSTEMS ENGINEERING ANALYSIS OF THE PESTONI PILLARS AS THEY APPLY TO USN SURFACE WARSHIPS

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Thomas H. Hatch, Civilian, Department of the Navy
Shawn M. Nibert, Civilian, Department of the Navy
Daniel J. Wirth, Civilian, Department of the Navy

Master of Science in Systems Engineering

Advisor: Bryan M. O'Halloran, Department of Systems Engineering
Co-Advisor: Paul T. Beery, Department of Systems Engineering

This project develops a tool to better understand the impact of resource allocation on fleet readiness for the future guided-missile frigate, FFG(X). This project assesses the FFG(X) in terms of the PESTONI pillars (Personnel, Equipment, Supply, Training, Ordnance, Network, and Infrastructure). To use the PESTONI framework as a way to increase FFG(X) readiness, both a qualitative and a quantitative solution were developed. The qualitative solution is a series of failure propagation chain diagrams that represent how funding changes within one pillar affect the other pillars. The quantitative solution is the readiness model itself. The readiness model decomposes each pillar in a way that is relatable to the way the FFG(X) will operate when fielded. Once each pillar was independently constructed and tested, the pillars were interconnected in the same way they are presented in the failure propagation chain diagrams. The designed operation of the readiness model is to load the model with pertinent FFG(X) data that is then used in conjunction with both current and future funding allocations to estimate FFG(X) readiness. The readiness model is verified using multiple use case scenarios that demonstrate funding shifts cannot simply be equal across the PESTONI pillars, but they must be optimized to maximize FFG(X) readiness. The FFG(X) readiness model aims to present the user with objective information that will aid in producing the highest possible ship readiness.

Keywords: future guided-missile frigate; FFG(X); PESTONI pillars; Personnel, Equipment, Supply, Training, Ordnance, Network, and Infrastructure

INTEGRATING POWER-FLOW, RESILIENCE, AND COST MODELS FOR NAVAL INSTALLATION MICROGRIDS

This paper has been recognized as outstanding by its department.

Curtis D. Bolen, Lieutenant, United States Navy
Victoria Chu, Civilian, Department of the Navy
Andy Q. Dang, Civilian, Department of the Navy
Paul T. Kim, Civilian, Department of the Navy
Christian Proctor, Civilian, Department of the Navy
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Master of Science in Systems Engineering

Advisor: Douglas L. Van Bossuyt, Department of Systems Engineering
Co-Advisor: Giovanna Oriti, Department of Electrical and Computer Engineering

Existing military microgrid analysis tools lack an integrated system analysis process to fully assess energy resilience and microgrid cost. This capstone describes the development of a common streamlined tool and methodology to improve the ability to assess energy resilience for military microgrids using event scenarios including deliberate attacks and natural disasters. The resilience metric used in this report, defined as the expected lifecycle mission impact (ELMI), quantifies microgrid resilience in terms of the microgrid's ability to minimize mission impact against all potential threats to power disruption. The tool considers a realistic set of scenarios that could disrupt power allowing users to compare distributed energy resource (DER) changes against a single microgrid architecture to determine the best balance between cost and resilience. Users can configure the tool to allow for change in microgrid load or updates to equipment costs. A supplemental user's guide provides a thorough walkthrough of the tool, and a supplemental case study demonstrates the tool functionality by analyzing an existing naval installation microgrid.

Keywords: microgrid, resilience, system engineering, naval installation, trade-off analysis, cost, expected lifecycle mission impact, ELMI, distributed energy resource, DER

BUILDING RESILIENCE WITHIN DOD MICROGRIDS BY CONSIDERING HUMAN FACTORS IN RECOVERY PROCEDURES

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Advisor: Douglas L. Van Bossuyt, Department of Systems Engineering
Co-Advisor: Daniel Eisenberg, Department of Operations Research

In support of the National Defense Strategy, the Department of Defense (DOD) has recognized energy security as an essential part of its strategic intent. In keeping with the DOD's strategic goals, the Department of the Navy announced three pillars of success to meet those goals: Resilience, Reliability, and Efficiency. To best establish energy security for DOD installations, microgrids have been embedded into the energy systems as additional energy sources and controls that support mission readiness. Previous microgrid resilience research has focused on system design and cost efficiency. Considering a different approach, this thesis will pose the question of whether established recovery procedures build resilience within DOD microgrids. Using the Human Performance Impact Recovery Analysis (HPIRA) tool developed as a part of this research, human cognition and human error are implemented into various recovery procedures to determine the most successful recovery times and the man-hours required for a successful recovery. This research demonstrates the impact of human cognition in human actions and allows microgrid stakeholders to understand how human factors impact a microgrid system's recovery.

Keywords: resilience, recovery procedures, microgrid, energy, reliability

TESTING WHETHER DISTRIBUTED ENERGY STORAGE RESULTS IN GREATER RESILIENCE OF MICROGRIDS

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Second Reader: Ronald E. Giachetti, Department of Systems Engineering

This research examines whether distributing energy storage systems (ESS) improves microgrid resilience. A resilience definition appropriate for a military context substantiates the selection of three resilience measures for quantifying the change in resilience between a single ESS baseline microgrid architecture, and double and quintuple ESS architectures. Mission impact (MI) from Peterson (2019), islanding time from Van Broekhoven et al. (2014), and average θ glideslope, θg, adapted from Wang and Yoda (2016), are the resilience measures used by a modified resilience analysis process (RAP) adapted from Vugrin et al. (2017). Three equivalent hazard simulation models only differ in the number of ESSs geographically distributed across the microgrid. Macro-enabled MS Excel-based versions of the Monterey Microgrid Simulation Model (Peterson 2019) execute scenario simulations in an hourly timestep over a 24-hour period presenting hazards ranging from component failures to wide-area destructive events (e.g., explosions). The analyses identify greater resilience in microgrids with distributed ESS versus centralized ESS. Furthermore, increased inter-bus connections and energy flow combinations improve resilience in concert with increased ESS distribution.

Keywords: energy storage, microgrid, resilience, distributed energy storage, resilience simulation, interdependence, energy capacity allocation, resiliency

IDENTIFYING THE KEY MISCONCEPTIONS IN SYSTEMS ENGINEERING

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Second Reader: Anthony G. Pollman, Department of Systems Engineering

Systems engineering (SE) is a field of study filled with various topics, and professionals enter the field along different educational pathways. Some system engineers have formal education, while others rely on prior background studies or on-the-job training. Although past studies highlight the core competencies needed to perform in an SE position adequately, they do not address the core concepts learned by students in a foundational SE course. This research identified the core concepts employing a qualitative data analysis method using subject matter experts. The research team selected subject matter experts from Naval Postgraduate School (NPS), Massachusetts Institute of Technology (MIT), Naval Sea Systems Command (NAVSEA), and industry. The team determined the core concepts by comparing the SE literature and contrasting the findings from the subject matter expert interviews. Additionally, this research identified problems in systems engineering design and issues students have with understanding core concepts. This research is designed to improve student learning in an educational environment. This research can be developed further by exploring other SE subfields in similar ways to find the concepts that exist in other SE subfields and how they overlap. Furthermore, the core concepts could be applied to create a concept inventory that would increase student knowledge transfer in the SE concepts.

Keywords: systems engineering, Delphi method, concept inventory, engineering education, Massachusetts Institute of Technology, MIT, Naval Sea Systems Command, NAVSEA

AI-BASED UXO DETECTION USING SUAS EQUIPPED WITH A SINGLE- OR MULTI-SPECTRUM EO SENSOR

This paper has been recognized as outstanding by its department.

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Master of Science in Engineering Systems
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Second Reader: Fotis A. Papoulias, Department of Systems Engineering

Unexploded ordnance (UXO) poses a threat to soldiers operating in mission areas, but current UXO detection systems do not provide the required safety and efficiency to protect soldiers from this hazard. Recent technological advancements in artificial intelligence (AI) and small unmanned aerial systems (sUAS) present an opportunity to explore a novel concept for a UXO detection system. The system proposed in this study integrates a sUAS with an onboard single- or multiple-spectrum (MS) electro-optical (EO) sensor. The major contributions of this thesis include the development of an AI-based algorithm for reliable UXO detection using a Deep Learning Convolutional Neural Network, execution of experiments to validate the proposed system's performance, and analysis of the proposed system's feasibility. To that end, the thesis describes the development of the UXO detector for a single-spectrum sensor, followed by the development and integration of five UXO detectors for the MS sensor. The field experiment conducted using a commercial-off-the-shelf (COTS) sUAS equipped with a standard EO sensor is also described. This thesis concludes that AI-based UXO detection using a single-spectrum or MS sensor flown on a COTS sUAS is a feasible solution. The thesis also proposes the steps for further enhancement and improvement of the developed system and lays out additional test and evaluation strategies to fully test the developed capability.

Keywords: unexploded ordnance, UXO, artificial intelligence, AI, small unmanned aerial systems, sUAS, object detection, deep learning, DL, Convolutional Neural Network, CNN, multiple-spectrum, MS, electro-optical, EO sensor, commercial-off-the-shelf, COTS

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